[redacted]

CLASSIFICATION CHANGE

To UNCLASSIFIED

By authority of GDS-GP-4 Date 10-75

Changed by L. Shirley

Classified Document Master Control Station, NASA

Scientific and Technical Information Facility

4160-6047-TC000

NAS9-2938

NASA-MSC-G-R-65-2

Supplemental Report 4

GEMINI GT-3

INERTIAL GUIDANCE SYSTEM EVALUATION

TRAJECTORY RECONSTRUCTION (U)

(NASA-TM-X-61009) GEMINI GT-3 INERTIAL GUIDANCE SYSTEM EVALUATION TRAJECTORY RECONSTRUCTION (NASA) 102 p

N79-76309

Unclas

00/18 11087

(PAGES) (CODE)

TMX61009

(NASA CR OR TMX OR AD NUMBER) (CATEGORY)

FF No. 602(A

[redacted]

17 MAY 1965

Published as Supplemental Report 4
to the Gemini Program Mission Report GT-3
(Gemini 3) MSC-G-R-65-2 by:

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas

TRW SPACE TECHNOLOGY LABORATORIES

THOMPSON RAMO WOOLDRIDGE INC.

[redacted]

C68-3653

[redacted]

4160-6047-TC000

NAS9-2938

Total Pages: 102

NASA-MSC-G-R-65-2

Supplemental Report 4

GEMINI GT-3

INERTIAL GUIDANCE SYSTEM EVALUATION TRAJECTORY RECONSTRUCTION (U)

~~GROUP 4~~
~~Downgraded at 3 year intervals; declassified after 12 years~~

17 MAY 1965

Published as Supplemental Report 4
to the Gemini Program Mission Report GT-3
(Gemini 3) MSC-G-R-65-2 by:

National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas

TRW SPACE TECHNOLOGY LABORATORIES
THOMPSON RAMO WOOLDRIDGE INC.

~~DOWNGRADED AT 3 YEAR INTERVALS;~~
~~DECLASSIFIED AFTER 12 YEARS.~~
~~DOD DIR 5200.10~~

~~CONFIDENTIAL~~

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

GEMINI GT-3
INERTIAL GUIDANCE SYSTEM EVALUATION
TRAJECTORY RECONSTRUCTION

4160-6047-TC000

17 May 1965

By

P. M. Jackson

W. R. Anders

Approved By: Robert J. Boyles
R. J. BOYLES

Approved By: W. Schroeder
W. SCHROEDER

DOWNGRADED AT 3 YEAR INTERVALS;
DECLASSIFIED AFTER 12 YEARS
DOD DIR 5200.10

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

TABLE OF CONTENTS

Section		Page
1.0	Introduction	1
2.0	Summary	3
3.0	Ascent Analysis	5
4.0	Re-Entry Analysis	29
5.0	Trajectory Reconstruction	39
6.0	Tracking System Performance	59
7.0	References	71

Table		
I	Guidance Error At SECO	10
II	GT-3 Navigation Errors	11
III	Ascent Phase IMU Analysis Recovered Coefficients	15
IV	Accelerometer Bias And Scale Factor Summary	24
V	Errors At SECO	25
VI	Azimuth Update	27
VII	Indicated Position Summary	30
VIII	Re-Entry Analysis Recovered Error Source Coefficients	38

TABLE OF CONTENTS
(Continued)

Appendix		Page
I	Ascent Thrust Profile	72
II	Re-Entry Thrust Profile	84
III	Ascent Gimbal Angles And Attitude Errors	94

Total Pages: 102

LIST OF FIGURES

Figure		Page
1	GE Final And 100K MISTRAM ΔV, Thrust Coordinates	6
2	GE Final And 100K MISTRAM ΔP, Thrust Coordinates	7
3	GE Final And 100K MISTRAM ΔV, Guidance Inertial Coordinates	8
4	Navigation Velocity Error	9
5	100K MISTRAM ΔV, Thrust Coordinates, Calibration Comparison	13
6	100K MISTRAM ΔV, Thrust Coordinates, Calibration Comparison	14
7	Free-Flight Velocity Errors, Thrust Coordinates	19
8	Pitch Malfunction Error Propagation Curves	22
9	Re-Entry Mode ΔP State Vector Initialized Guidance Trajectory	32
10	Re-Entry Mode ΔV State Vector Initialized Guidance Trajectory	33
11	Re-Entry Mode ΔP, Radar Initialized Guidance Trajectory	35
12	Re-Entry Mode ΔV, Radar Initialized Guidance Trajectory	36
13	Re-Entry Mode Special Parameters	53
14	GE/Burroughs And 100K MISTRAM ΔV, Thrust Coordinates	62
15	10K MISTRAM And 100K MISTRAM ΔV, Thrust Coordinates	64

LIST OF FIGURES
(Continued)

Figure		Page
16	Final MISTRAM And 100K MISTRAM ΔV, Thrust Coordinates	66
17	Passive MISTRAM And 100K MISTRAM ΔV, Thrust Coordinates	67
18	BET And 100K MISTRAM ΔV, Thrust Coordinates	68
19	Ascent Phase Thrust Profile	73
20	Inertial Flight Path Angle	74
21	Re-Entry Mode Thrust Profile	82
22	Gimbal Angles And Attitude Errors	95

Acknowledgements

The authors wish to thank R. J. Boyles for his contribution to this report and the computer programming staff headed by S. F. Needham and J. N. Bausch for the efficient and timely reduction of the data.

1.0 INTRODUCTION

GEMINI flight GT-3 was successfully launched on 23 March 1965 from Complex 19 at Cape Kennedy, Florida. This was the first manned orbital flight and the second to carry an inertial guidance system in the GEMINI spacecraft.

The purpose of this report is to present the results of the inertial guidance system analysis performed during ascent and re-entry and to provide a trajectory reconstruction of the spacecraft during ascent and re-entry.

The contents of this report are as follows:

Section 2.0 - Provides a summary of the significant analysis results determined from this flight.

Section 3.0 - Provides a detailed description of the analysis performed during the ascent portion of flight. This includes a discussion of; a) inertial measurement unit (IMU) accelerometer and platform errors, b) the radio guidance - inertial guidance update procedure, and c) airborne computer computation errors.

Section 4.0 - Provides a description of the IMU error analysis performed during re-entry and the correlation between the ascent and the re-entry IMU analyses.

Section 5.0 - Provides tabular listings of the trajectory reconstruction during ascent and re-entry.

Section 6.0 - Describes the external tracking system performance and quality.

Appendix - Contains listings and plots of the thrust acceleration profile for ascent and re-entry and plots of the ascent gimbal angles and attitude errors.

2.0 SUMMARY

The following is a brief summary of the major results from analysis of the data from this flight:

2.1 Excessive pitch type errors were noted during the ascent and re-entry modes of flight with magnitudes equivalent to the following constant pitch drift rates:

a. 1 deg/hr for the first 180 seconds of ascent.

b. 23 deg/hr after 180 seconds and at least until SECO.

c. 4.6 deg/hr during the entire post-retro phase of the re-entry mode.

Analyses of the observed errors and concurrent postflight tests on the GT-3 platform by Honeywell indicate the observed pitch errors are attributable to a malfunctioning Y gyro.

2.2 The major guidance system errors other than the pitch errors resulted from X and Z accelerometer scale factor errors of approximately 700 and 600 parts per million and bias errors of 340 and 180 ppm g respectively. Comparisons of calibration data indicated that the large scale factor errors would not have been present, resulting in considerable improvement in guidance velocity magnitude accuracy, had the latest preflight calibration data been used.

2.3 Analysis of the update procedure indicated negligible azimuth drifts during the ascent phase and successful accomplishment of the RGS/IGS update procedure.

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

2.4 There was no evidence of an accelerometer count gain malfunction as observed on the GT-2 flight (see Reference 3).

2.5 The best estimate of the re-entry trajectory based upon corrected guidance data indicates that the spacecraft was 14 nautical miles North and 59 nautical miles West of the desired impact point at 799 seconds after retrofire. (This was at approximately 50,000 feet altitude and corresponds to the last available guidance or tracker trajectory point.) The IMU error while large made a relatively small contribution to the total impact miss.

2.6 In general, the quality of the tracking data was excellent. The quick look MISTRAM data was much improved compared to GT-2.

The principal discrepancy in the data received on this flight was a large systematic error, amounting to 2-3 feet per second in $\dot{X}$ and 10-20 feet per second in $\dot{Y}$, noted between MISTRAM and GE Mod III late in flight.

Re-entry radar data was, in general, adequate with the exception of 3.18 data which exhibited very large systematic errors.

This document contains information affecting the national [redacted] States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

3.0 ASCENT ANALYSIS

3.1 Introduction

Flight time history comparisons were made between guidance system telemetered quantities and external tracking data for the purpose of evaluating the Inertial Measurement Unit (IMU) accuracies and the navigation performance on GT-3. The IMU evaluation is based on thrust velocity comparisons (Figure 1) between the telemetered accumulated accelerometer count data properly scaled and biased and external tracking data converted to guidance thrust velocities (gravity removed). The guidance coordinate system is an inertial, orthogonal, right-handed system aligned with the launch site at inertial T_o and referenced to the center of the earth. The X and Z axes lie in a plane parallel to the geodetic tangent plane with the X axis defined by the launch azimuth positive downrange. The Y axis is positive down along the geodetic vertical and Z is directed so as to complete the right-handed X, Y, Z set.

Comparisons were also made between the telemetered total inertial position and velocity output of the airborne computer and external tracking data (Figures 2, and 3). These are called inertial or total comparisons and include airborne computer navigation errors such as caused by gravity approximations, truncation errors, etc. The difference between this set of comparisons and the thrust comparison set (DELTA-DELTA Comparisons, Figure 4) provides a measure of the airborne computer navigation error.

This document contains information affecting the national [redacted] the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation [redacted] in any manner to an unauthorized person is prohibited by law.

Figure 1

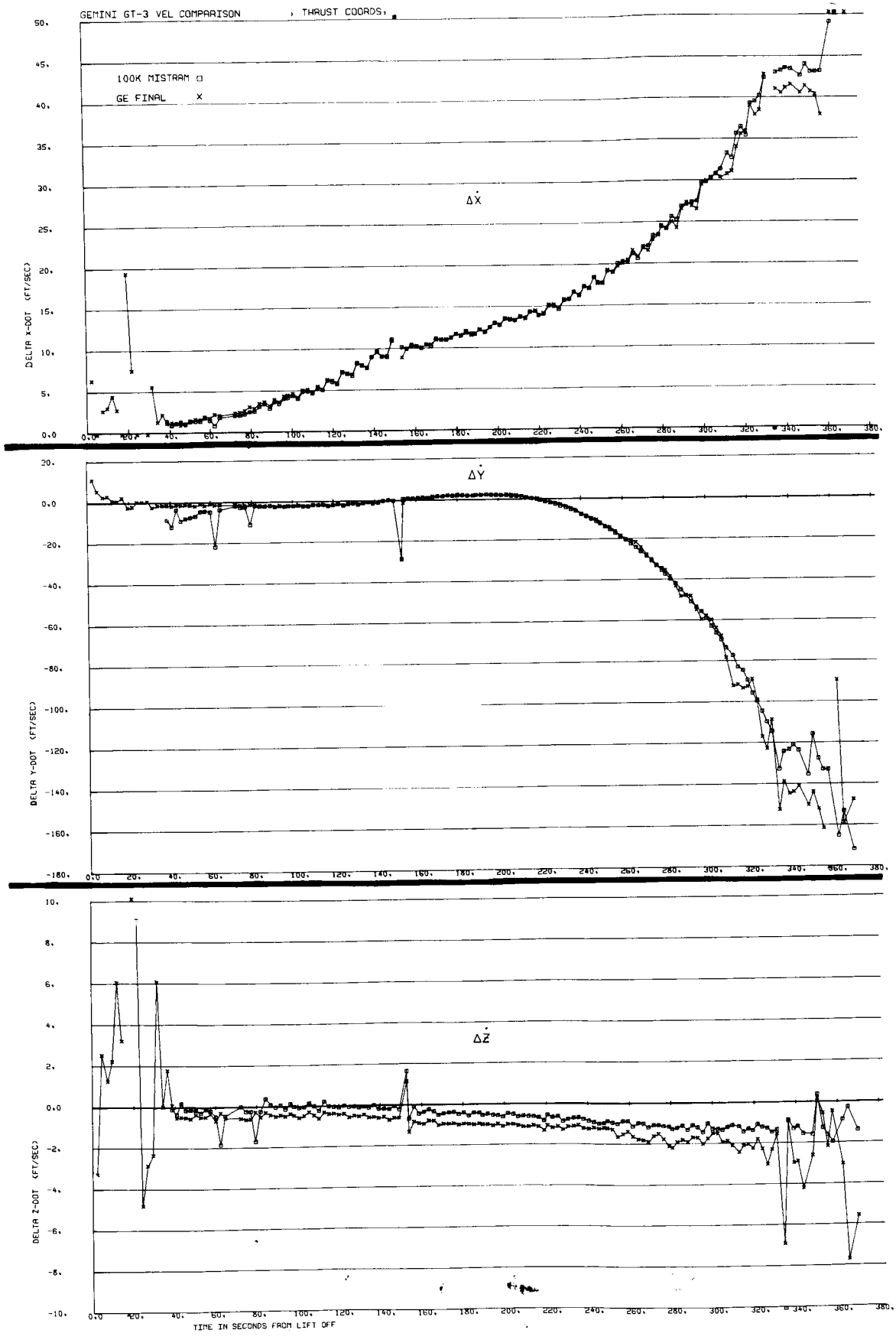

GEMINI GT-3 VEL COMPARISON , THRUST COORDS,
100K MISTRAM □
GE FINAL X
ΔẊ
DELTA X-DOT (FT/SEC)
ΔẎ
DELTA Y-DOT (FT/SEC)
ΔŻ
DELTA Z-DOT (FT/SEC)
TIME IN SECONDS FROM LIFT OFF

Figure 2

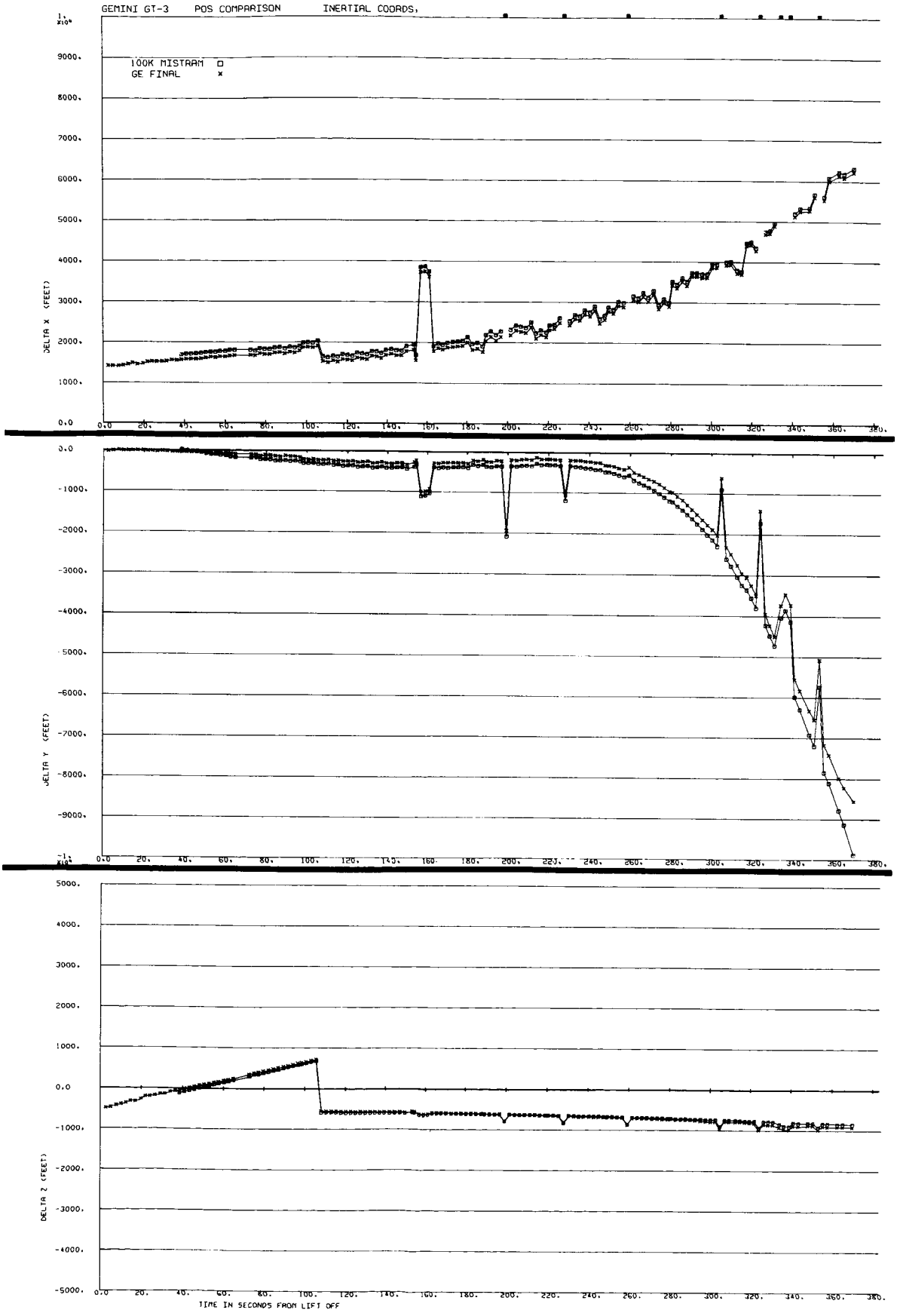

GEMINI GT-3 POS COMPARISON INERTIAL COORDS,
100K MISTRAM □
GE FINAL ×
DELTA X (FEET)
DELTA Y (FEET)
DELTA Z (FEET)
TIME IN SECONDS FROM LIFT OFF

Figure 3

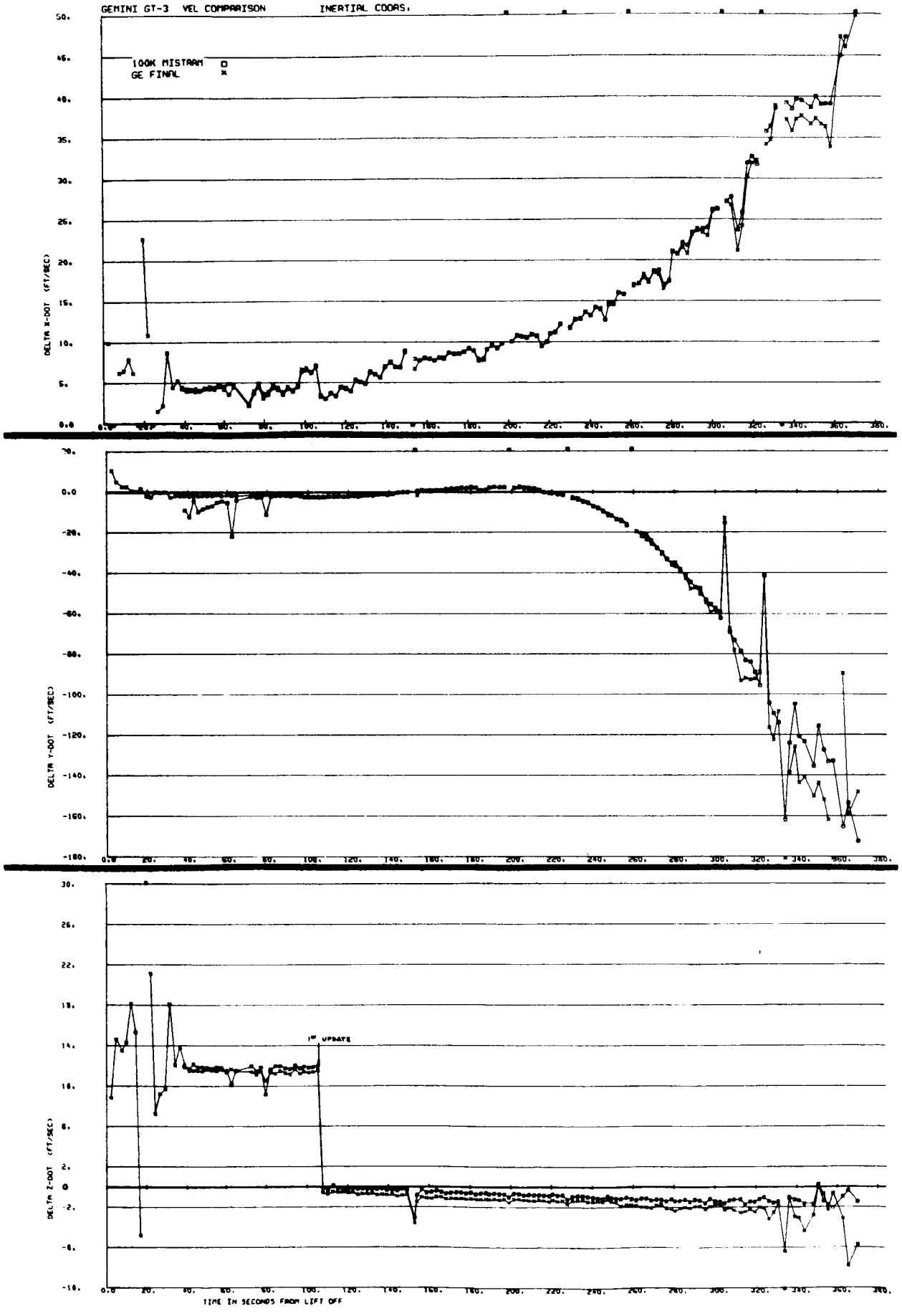
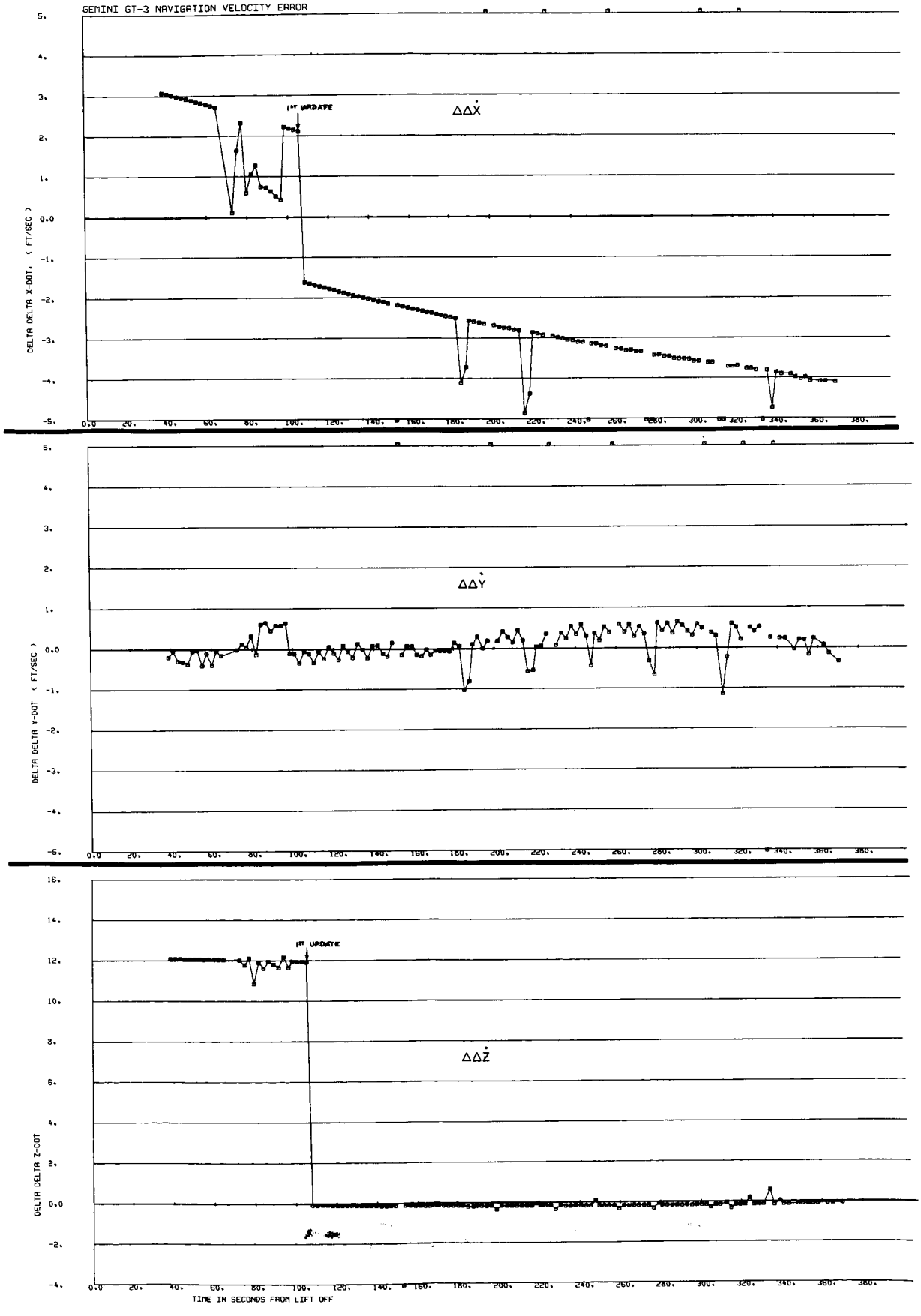

GEMINI GT-3 VEL COMPARISON INERTIAL COORS.
100K MISTRAM
GE FINAL
DELTA X-DOT (FT/SEC)
DELTA Y-DOT (FT/SEC)
DELTA Z-DOT (FT/SEC)
1st UPDATE
TIME IN SECONDS FROM LIFT OFF

Figure 4


GEMINI GT-3 NAVIGATION VELOCITY ERROR
1ST UPDATE
ΔΔẊ
DELTA DELTA X-DOT, (FT/SEC)
ΔΔẎ
DELTA DELTA Y-DOT (FT/SEC)
1ST UPDATE
ΔΔŻ
DELTA DELTA Z-DOT
TIME IN SECONDS FROM LIFT OFF

Comparisons were made using several sources of external tracking data including quick look MISTRAM I 10K and 100K, GE/Mod III/Final, GE Mod III/Burroughs, final MISTRAM, passive MISTRAM II and BET. The relative merits of these data sources are described in Section 6.0. The ascent analysis was based primarily on quick look MISTRAM I 100K data because of its superior quality. Details of the data processing required to obtain these comparisons are given in Reference 1.

The plots enclosed are referenced to liftoff which occurred 3.452 seconds after go inertial.

3.2 Guidance Error

The indicated guidance system error at SECO (334 seconds from liftoff) and equally valid at separation (359 seconds from liftoff) are given below. These values were obtained by examination of the position and velocity comparisons (Figures 1-4).

TABLE I

GUIDANCE ERROR AT SECO

	IMU Error	Navigation Equation Errors	Total Guidance Error
$\Delta\dot{X}$	41.0 ± 1	-3.7 ± .1	37.3 ± 1
$\Delta\dot{Y}$	-162.0 ± 1.5	+ .50 ± .1	-161.5 ± 1.5
$\Delta\dot{Z}$	-2.5 ± .1	- .15 ± .1	-2.6 ± .1
ΔX	5100 ± 200	452	5552 ± 200
ΔY	-5200 ± 50	111	-5089 ± 50
ΔZ	-1000 ± 50	-568	-1568 ± 50

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

The column headed IMU ERROR represents the error contributed by the accelerometer and gyro sources, that headed NAVIGATION EQUATION ERRORS is the contribution due to various approximations within the airborne computer as observed from the Delta Delta Comparisons* and that titled TOTAL GUIDANCE ERROR is the sum of the two and represents the total IGS error. These total errors result in velocity magnitude and flight path angle errors at release of the following amounts

$$\Delta |V| = 12 \text{ fps}$$

$$\Delta \gamma = .38 \text{ deg}$$

The following table is a comparison between the navigation errors observed on this flight and those predicted by preflight simulation.**

TABLE II

GT-3 NAVIGATION ERRORS

	Position (ft)			Velocity (ft/sec)		
	X	Y	Z	$\dot{X}$	$\dot{Y}$	$\dot{Z}$
Actual	452	111	-568	-3.7	.5	-1.5
Simulated	51	0	-160	-3.25	1.45	- .45

The observed differences are most likely attributable to computational errors caused by the large position errors observed on this flight.

* Level changes at 106 seconds in the $\dot{X}$ and $\dot{Z}$ curves are due to updating the initial earth rate conditions by the onboard computer as a result of the RGS/IGS update routine.

** The preflight simulation values were obtained by telephone from IBM.

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

3.3 IMU Analysis

The thrust coordinate velocity comparison plots (Figures 5 and 6) indicate large steadily increasing X axis velocity errors throughout flight; and rapid negatively increasing Y velocity errors, beginning approximately 180 seconds from liftoff, abruptly reversing an increasing positive trend prior to that time. These anomalies are attributable primarily to excessive X and Z accelerometer bias and scale factor errors, and a pitch drift malfunction error occurring at approximately 180 seconds.

Preliminary observations of the data revealed that the major portion of the X error prior to 180 seconds could be attributable to an X accelerometer scale factor error; however, the velocity error trend beyond this period suggested the presence of an additional large magnitude error source. Since both the X and Y axis velocity comparisons indicated the presence of a large magnitude error source beginning mid-flight while the Z axis seemed unaffected, it was concluded that a pitch type malfunction must have occurred during the latter period of the ascent phase.

Because of this apparent malfunction it was necessary to perform a separate analysis before and after this occurrence. Table III summarizes the results of this analysis by listing error coefficients that could account for the ascent IMU error. This partitioning of the flight into time intervals lessened the accuracy with which the IMU errors could be isolated, but permitted the identification of the type of errors present (i.e., gyro versus accelerometer or drift versus measurement) and approximate equivalent magnitudes.

This document contains information affecting the national defense [illegible] States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which [illegible] any manner to an unauthorized person is prohibited by law.

Figure 5

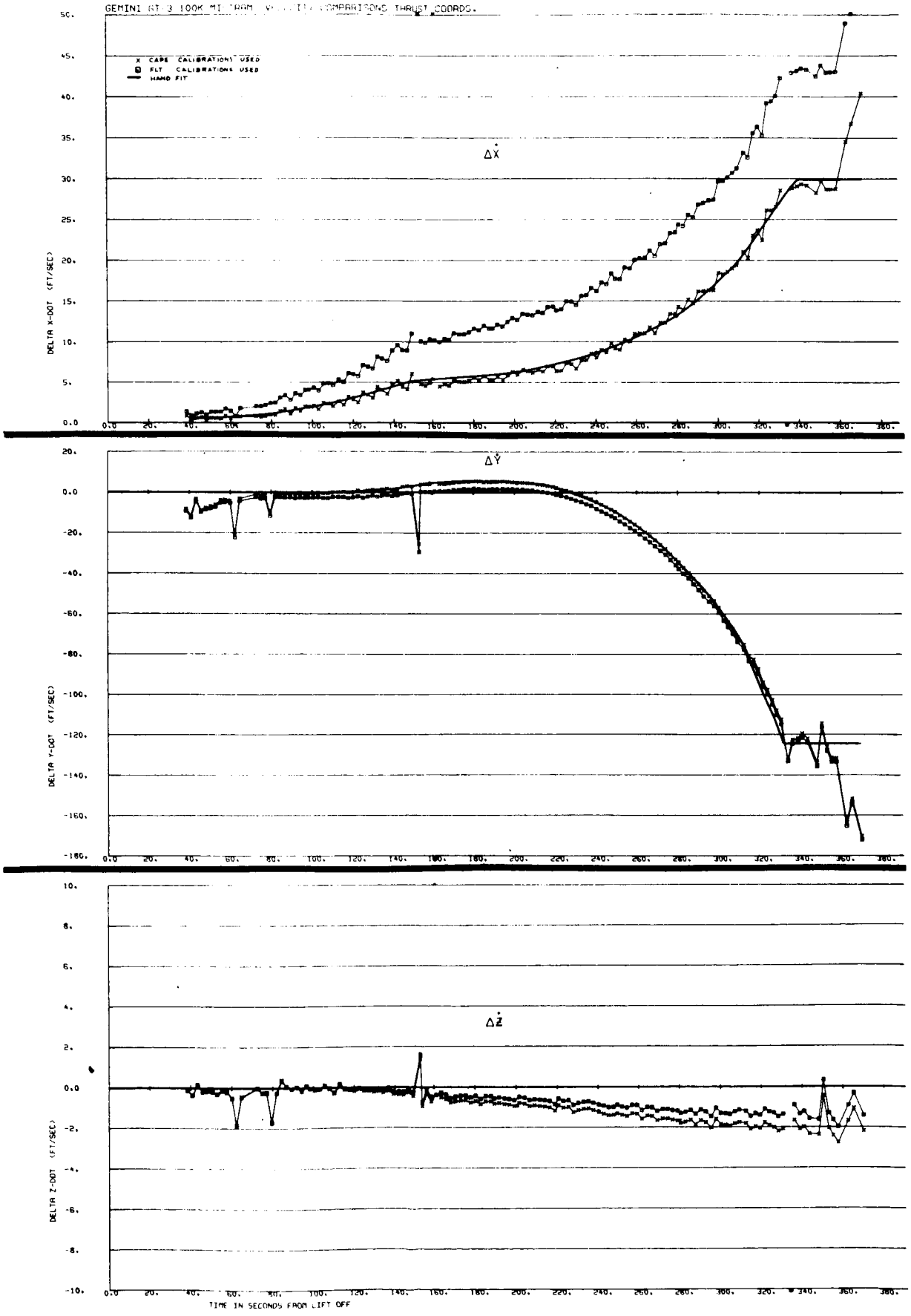

GEMINI GT-3 100K MI. TRAM. V... COMPARISONS THRUST COORDS.
X CAPE CALIBRATIONS USED
FLT CALIBRATIONS USED
HAND FIT
ΔẊ
DELTA X-DOT (FT/SEC)
ΔẎ
DELTA Y-DOT (FT/SEC)
ΔŻ
DELTA Z-DOT (FT/SEC)
TIME IN SECONDS FROM LIFT OFF

Figure 6

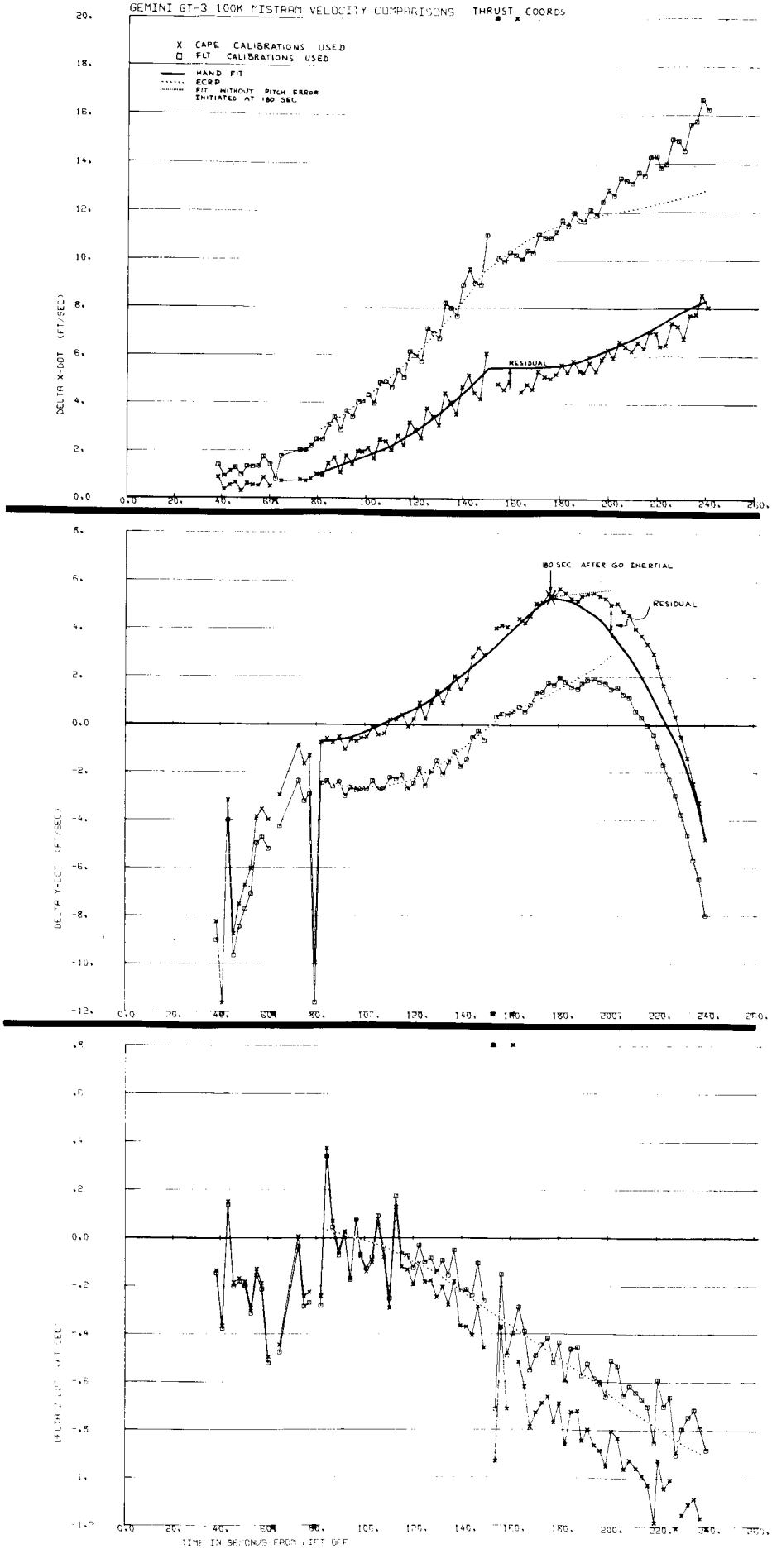

GEMINI GT-3 100K MISTRAM VELOCITY COMPARISONS THRUST COORDS
X CAPE CALIBRATIONS USED
O FLT CALIBRATIONS USED
HAND FIT
ECRP
FIT WITHOUT PITCH ERROR INITIATED AT 180 SEC
RESIDUAL
DELTA X-DOT (FT/SEC)
180 SEC AFTER GO INERTIAL
RESIDUAL
DELTA Y-DOT (FT/SEC)
TIME IN SECONDS FROM LIFT OFF

TABLE III

ASCENT PHASE IMU ANALYSIS RECOVERED COEFFICIENTS

Symbol	Error Source	Recovered Coefficient	
VOX	X accel initialization	-.25	fps
VOZ	Z accel initialization	-1.2	fps
XSF	X accel scale factor	687	ppm
ZSF	Z accel scale factor	522	ppm
B_x	X accel bias	340	ppm g
B_y	Y accel bias	-22	ppm g
B_z	Z accel bias	180	ppm g
YGCDR	Y gyro constant drift rate	1.0	deg/hr
DT	Time correlation error	-.005	sec
YGCDR (180)	Y gyro constant drift rate initiated (180 seconds from go inertial)	23	deg/hr

This document contains information affecting the national de[redacted] the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelatio[redacted] in any manner to an unauthorized person is prohibited by law.

3.3.1 Ascent Flight Prior to 180 Seconds

The first attempts at error source isolation involved the use of the Error Coefficient Recovery Program (ECRP) described in Reference 1. However, regressions using large error models such as that recommended in the GEMINI Accuracy Prediction Study, Reference 2, would not yield satisfactory results due to the similarity of error source propagations over this short time span. The usable data interval for regression which was very short (115 seconds) necessitated the making of a series of regressions using 5 to 10 term error models. The terms used in the regression were selected primarily because of their representative types of propagations. These included the following:*

1.	BX	X accelerometer bias
2.	BY	Y accelerometer bias
3.	BZ	Z accelerometer bias
4.	XSF	X accelerometer scale factor
5.	ZSF	Z accelerometer scale factor
6.	PHIY	Platform misalignment about Y accel axis
7.	PHIZ	Platform misalignment about Z accel axis
8.	YGCDR	Y gyro constant drift rate
9.	YGIAU	Y gyro input axis unbalance
10.	XQUAD	X accelerometer quadratic non-linearity
11.	ZXMSL	Z accelerometer misalignment toward X
12.	VOZ	Z accelerometer initialization error

* Error source notations refer to the hardware definition of the axes which has the Y accelerometer and gyro along the negative Z computer direction; the Z accelerometer and gyro along the Y computer direction and the X accelerometer and gyro axes coinciding with the computer X axis.

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

Figure 6 shows a fit obtained from one of the regression solutions. The error coefficients recovered from that solution which is typical of the regressions performed are indicated below.

X accelerometer scale factor	339 ppm
Z accelerometer scale factor	611 ppm
X accelerometer bias	467 ppm g
Y accelerometer bias	92 ppm g
Z accelerometer bias	-414 ppm g
Platform misalignment about Y accelerometer axes	80 $\widehat{sec}$
Platform misalignment about Z accelerometer axes	-6.9 $\widehat{sec}$
Y gyro constant drift rate	1.6 deg/hr
Z accelerometer initialization	.613 fps

The above coefficients are similar to those recovered from other regressions with the exception of the X and Z accelerometer biases which varied between large positive and negative values with successive error model variations. This is attributable to their high correlation with the pitch type error sources. The above coefficients were used in the trajectory reconstruction discussed in Section 5 because they provided the best fit to the early data.

Most significant among the regressions was the consistent indications of X and Z accelerometer scale factor errors of approximately 500 and 600 ppm and Y gyro constant drift rates between 1 and 1.6 degrees per hour. Discussions of these results at the Honeywell Company revealed that the above scale factor errors were consistent with the differences noted between successive calibrations (see Section 3.5). It was also noted that the Y gyro demonstrated constant drift rates of approximately 1 degree per hour during postflight tests of the GT-3 platform.

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

Based upon the above results, further attempts to isolate the IMU errors were accomplished by using what was considered to be the best available set of calibrations. These were the accelerometer scale factor and misalignment values of the Cape calibrations and the accelerometer biases obtained from the analysis of the free flight velocity errors. These velocity errors during portions of the catch-up and re-entry mode are shown in Figure 7.

Figure 7 is a plot of scaled and corrected thrust velocity during time intervals of flight where the spacecraft is in virtual free flight. Since there should be no net accelerometer velocity output, all the indicated trends were assessed to be incorrect accelerometer biases.

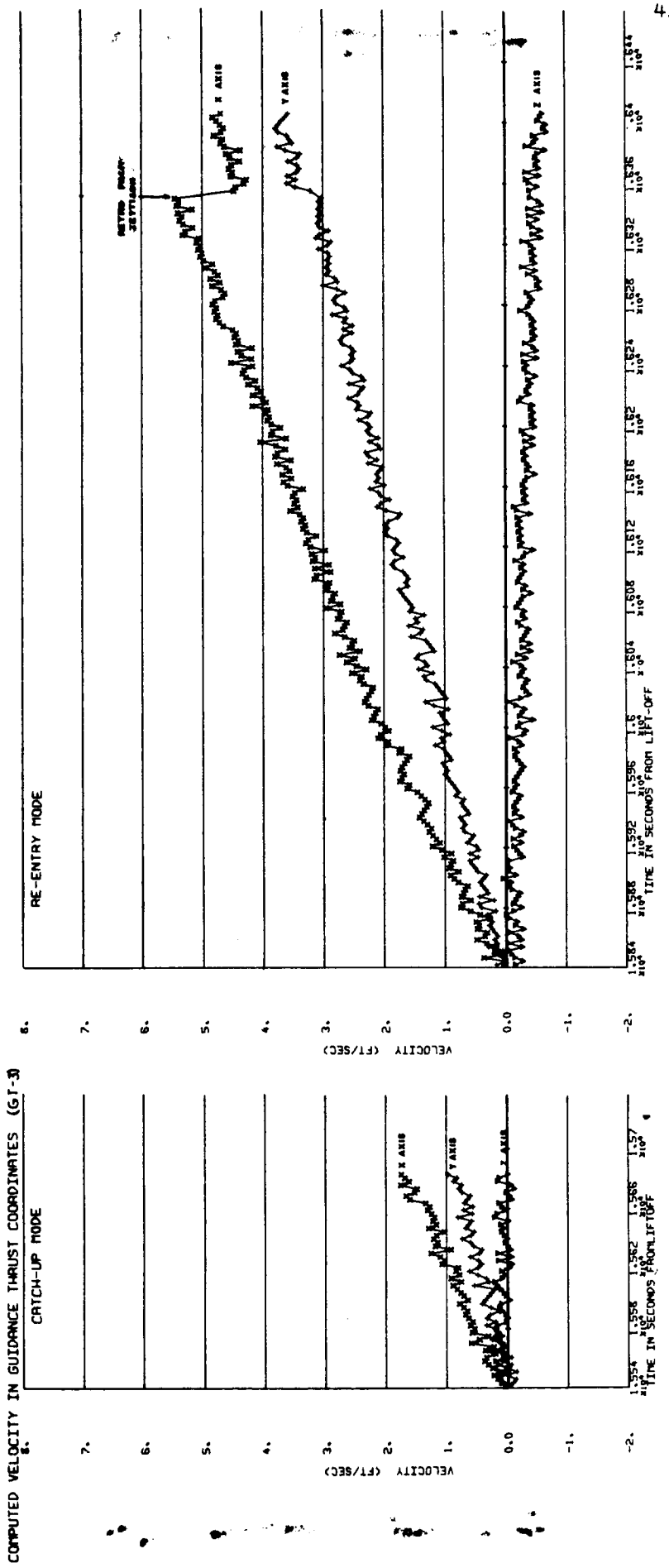
The velocity comparisons resulting from the new set of calibration data are shown in Figures 5 and 6 where the term CAPE CALIBRATIONS refers to the combined set mentioned above. With the removal of the apparent calibration errors, hand fits of the new comparison curves were accomplished. These resulted in the following error source coefficients.

Z accelerometer initialization	-1.2 fps
Y gyro constant drift rate	1.0 deg/hr
X accelerometer initialization	-.25 fps
X accelerometer scale factor	267 ppm

The residuals indicated in Figures 5 and 6 show approximately .6 fps difference between the hand fit curve and the data at 160 and 340 seconds. This difference is attributed to a 5 millisecond time correlation error. The hand fit results are not as exact a fit to the observed error as could be expected consistent with MISTRAM accuracies; however, they do substantiate the drift type errors recovered by the regression and also indicate the presence of additional X accelerometer scale factor error.

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of [redacted] manner to an unauthorized person is prohibited by law.

Figure 7


COMPUTED VELOCITY IN GUIDANCE THRUST COORDINATES (GT-3)
CATCH-UP MODE
RE-ENTRY MODE
VELOCITY (FT/SEC)
TIME IN SECONDS FROM LIFTOFF
X AXIS
Y AXIS
Z AXIS

3.3.2 Ascent Flight After 180 Seconds from Go-Inertial

The analysis of the later portion of the ascent flight consisted of determination of the time of malfunction occurrence, and isolation of the type of malfunction which caused the excessive Y axis velocity error.

Figure 6 which is a velocity comparison of the early portion of the ascent flight, shows a Y velocity error trend reversal beginning at approximately 180 seconds after go inertial. The X axis errors also show a rapid departure from the extension of the ECRP fit at this time. Observing the extension of the hand fit results between 180 and 200 seconds, it can be seen that the occurrence could have initiated at any time during that interval. Attempts to correlate this interval with flight events revealed only a rapid change in Y acceleration between 180 and 190 seconds from liftoff corresponding to the pitch down maneuver at that time (see Appendix I, Figure 19).* Because of the uncertainties in establishing the exact time by visual means, the time the occurrence initiated was considered in the analysis to be between 165 and 200 seconds from go inertial with close establishment of the time to result from attempts to provide curve fits to the data.

---

* Honeywell is conducting studies to determine the behavior of the Y gyro response to the observed acceleration profile. Preliminary information indicates peculiar but not completely consistent gyro drift when the acceleration changes sign along the Y gyro spin axis.

This document contains information affecting the national defense of [redacted] States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in [redacted] to an unauthorized person is prohibited by law.

Efforts to isolate the type and magnitude of the malfunction were based upon the assumption that the malfunction could be approximated by a single stationary error source initiated at one instant of time. Therefore, based upon this assumption, the IMU error simulation program (see Reference 1) was modified to generate unit error propagations at discrete times after go inertial. Figure 8 presents plots of three of the error source propagations generated by the program. These are pitch type error sources including Y gyro constant drift rate, Y gyro input axis unbalance and platform misalignment about the Y accelerometer axis. These were considered the more probable based upon comparing their propagations with the observed flight X and Y axis velocity errors.

A composite hand fit to the Cape calibration velocity comparisons was accomplished resulting in the following recovered coefficients from the entire ascent phase.

Z accelerometer initialization	-1.2 fps
Y gyro constant drift rate (from go inertial)	1.0 deg/hr
X accelerometer initialization	-.25 fps
X accelerometer scale factor	267 ppm
Y gyro constant drift rate beginning at 177 seconds (180 from go inertial)	23 deg/hr
Time correlation	-.005 seconds

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

Figure 8

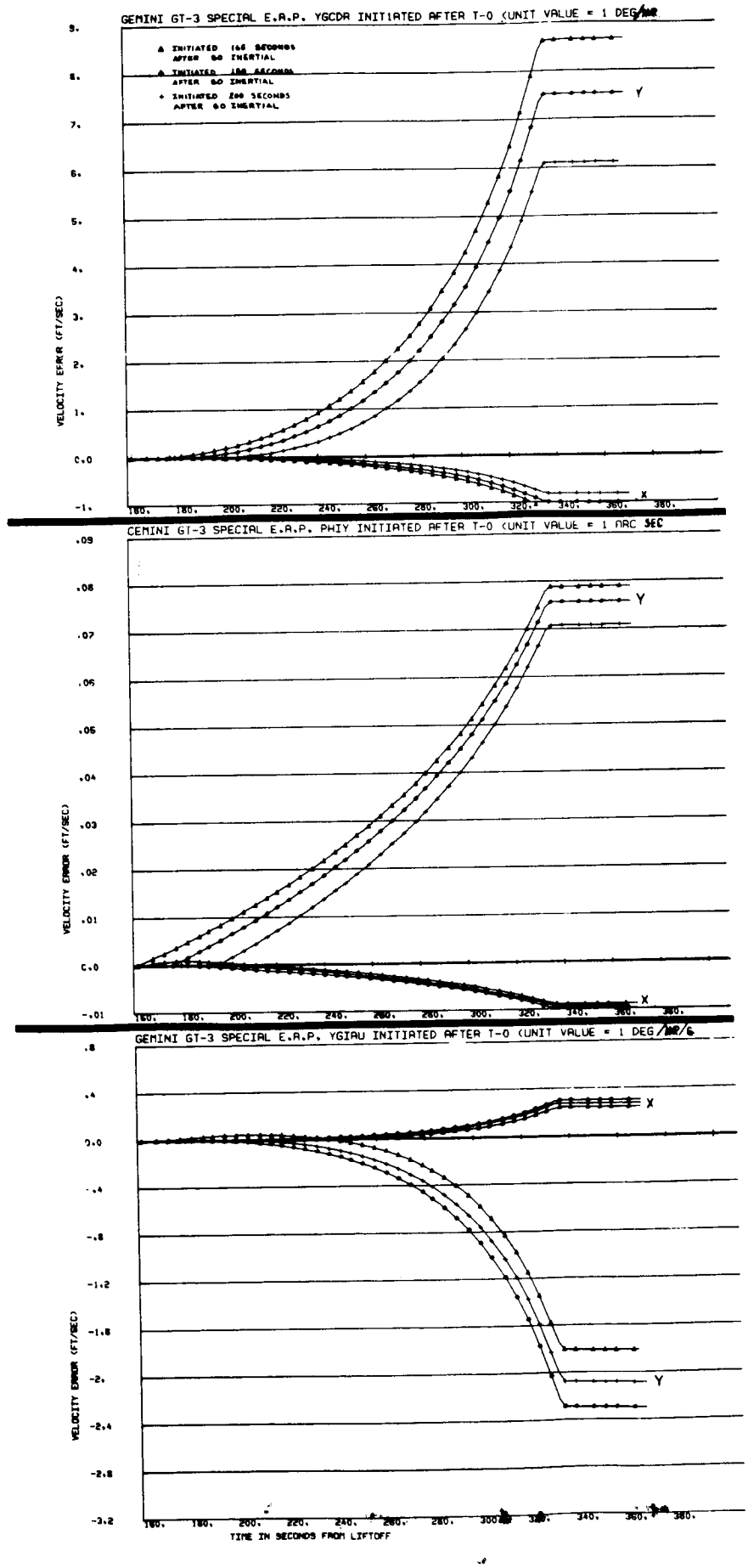

GEMINI GT-3 SPECIAL E.A.P. YGCDR INITIATED AFTER T-0 (UNIT VALUE = 1 DEG/HR
INITIATED 160 SECONDS AFTER 60 INERTIAL
INITIATED 180 SECONDS AFTER 60 INERTIAL
INITIATED 200 SECONDS AFTER 60 INERTIAL
VELOCITY ERROR (FT/SEC)
Y
X
GEMINI GT-3 SPECIAL E.A.P. PHIY INITIATED AFTER T-0 (UNIT VALUE = 1 ARC SEC
VELOCITY ERROR (FT/SEC)
Y
X
GEMINI GT-3 SPECIAL E.A.P. YGIAU INITIATED AFTER T-0 (UNIT VALUE = 1 DEG/HR/G
VELOCITY ERROR (FT/SEC)
X
Y
TIME IN SECONDS FROM LIFTOFF

Figure 7

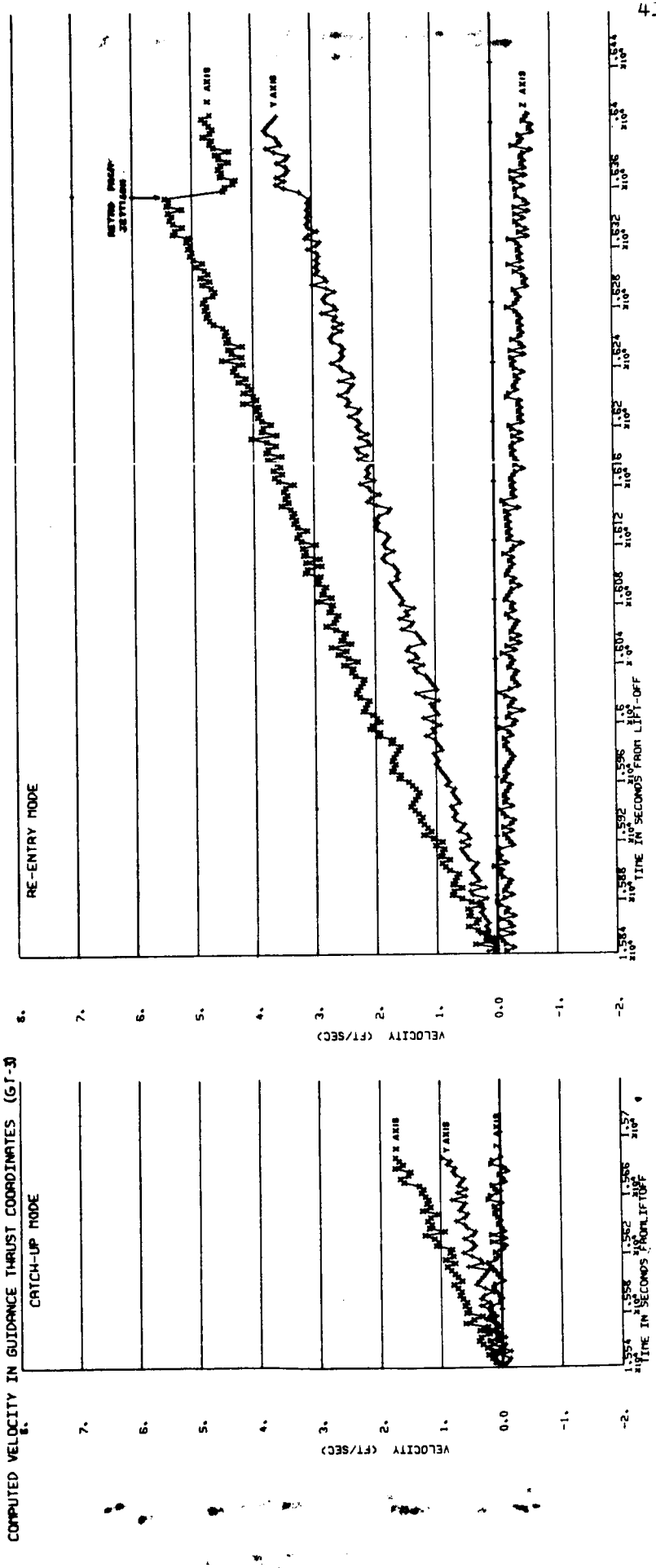
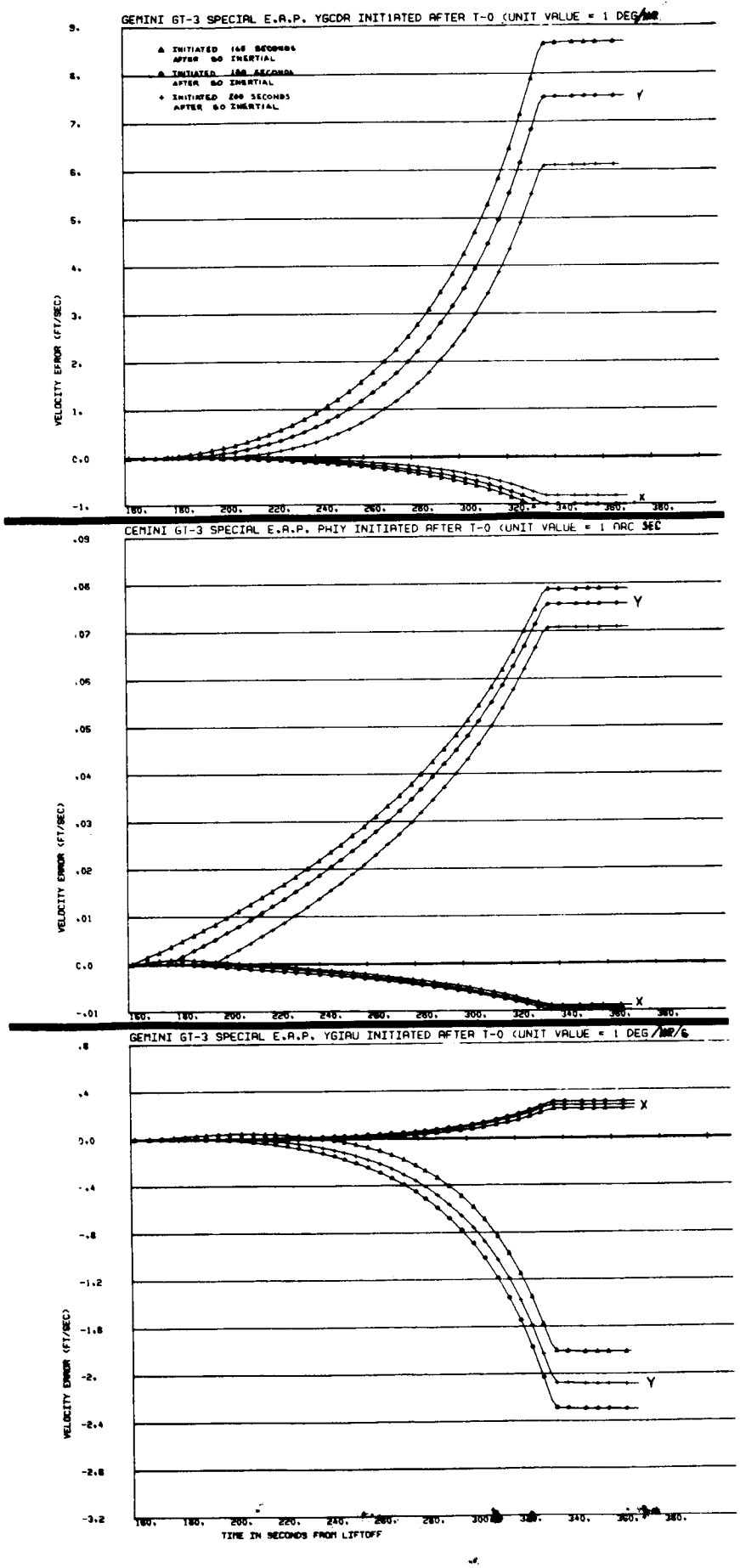

COMPUTED VELOCITY IN GUIDANCE THRUST COORDINATES (GT-3)
CATCH-UP MODE
RE-ENTRY MODE
VELOCITY (FT/SEC)
TIME IN SECONDS FROM LIFT-OFF
X AXIS
Y AXIS
Z AXIS

Figure 8

3.3.2



* Hon
res
ind
acc

The hand fit curve shown in Figures 5 and 6 resulted from the above coefficients with the exclusion of time correlation error which accounts for the residuals at 160 and 340 seconds. The residual at 200 seconds undoubtedly is due to the non-stationary nature of the malfunction and is a direct measure of the inadequacy of the basic stationary error assumption.

3.4 Preflight Calibrations

With the exception of X accelerometer bias, the calibrations used during flight, were those obtained at Honeywell on 26 February 1965. Another set of calibrations were obtained at Cape Kennedy prior to flight. These calibrations showed all the scale factor and X accelerometer bias values considerably different from those of the earlier set; however, only the X accelerometer bias value of the original (2-26-65) set was changed. Later X axis accelerometer calibrations showed additional large shifts in the X accelerometer bias and although the latest value was not flown, it was used in the ground alignment of the platform. The Honeywell and Cape calibration bias and scale factor values are shown in Table IV which also presents the accelerometer bias values determined from the postflight analysis of free flight velocity errors (Figure 7).

Table IV also indicates the difference between the Cape and Flight values the most significant of which are large magnitude scale factor changes of the three accelerometers. The X accelerometer was modified during the period between calibrations in an attempt to prevent the recurrence of the accelerometer malfunction noted on the GT-2 mission. This modification may provide an explanation for the observed variations of X accelerometer bias and scale factor; however, there are no obvious explanations for the 500 and 650 ppm Y and Z accelerometer scale factor differences between measurements. (1 σ specification is 130 ppm).

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

CONFIDENTIAL

TABLE IV

ACCELEROMETER BIAS AND SCALE FACTOR SUMMARY

	Flight	Honeywell 2-26-65	Cape 3-12-65	FF Analysis	Flt-Cape
X accel. SF	.10009750 fps/pulse	same as flt.	.10005550	Not Determined	420 ppm
Y accel. SF	.09029480 fps/pulse	same as flt.	.09023550	Not Determined	522 ppm
Z accel. SF	.09749790 fps/pulse	same as flt.	.09744700	Not Determined	657 ppm
X accel. bias	-.2616580 pulse/sec	+.18 (approx.)	same as flt.	-.1523	0
Y accel. bias	.2300020 pulse/sec	same as flt.	.218250	.223	-36.2 ppm g
Z accel. bias	.2233280 pulse/sec	same as flt.	.248254	.281	77.6 ppm g

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

CONFIDENTIAL

Except as otherwise noted, position and velocity comparisons were made by using the Flight calibrations. A set consisting of Cape calibration scale factors and misalignment terms and free flight determined biases was also used in the analysis of IMU performance. Figures 5 and 6 present velocity error curves resulting from the two sets of calibrations. These show a considerable decrease in the X axis velocity error due to using a later set of calibrations. A significant change in the early Y velocity error is also evident. Although the bias values used in generating the curves were obtained from postflight analyses, the major improvement in IMU errors is attributable to having the latest determined accelerometer scale factors. Table V shows the improvement in the error at SECO by using these Cape values.

TABLE V

ERROR AT SECO DUE TO CALIBRATIONS		VELOCITY ERROR AT SECO		
		X	Y	Z
Error at SECO (Flight Calibrations) 2/26/65		43	-127	-1.4
X accel. scale factor	-420 ppm	-10.4	0	0
Y accel. scale factor	-652 ppm	0	0	+ .23
Z accel. scale factor	-522 ppm	0	+3.6	0
X accel. bias	0	0	0	0
Y accel. bias	+36.6 ppm g	0	0	- .59
Z accel. bias	-77.6 ppm g	0	+ .84	0
Error at SECO (Cape Calibrations) 3/12/65		32.6	-122.6	- 1.77

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

The improvements resulting from Cape calibrations correspond to 11 fps total velocity and negligible difference in flight path angle.

3.5 Azimuth Update

An azimuth alignment correction is calculated at three separate times by the onboard computer. On the first pass through the navigation equations after platform release, the roll gimbal angle reading is compared with the desired value and the difference is used as a correction to the intended flight azimuth. This correction is called $\Delta\eta_x$ where a positive value implies that the platform is rotated clockwise from the desired azimuth.

The additional azimuth corrections are calculated during flight at 100 and 140 seconds after liftoff. These are calculated by comparing the crossrange (Z direction) velocity as measured by GE/Burroughs with that derived from the airborne system and attributing the residual to a platform misalignment.

The calculated updates are not telemetered; however, they are obtained quite accurately from the data analysis. Table VI summarizes the updates determined by the following methods:

1. Calculated by simulating the inflight calculations.

2. Calculated from the jumps in the inertial velocity comparisons or the DELTA DELTA curve.

3. Derived by IBM during their postflight simulation.

This document contains information affecting the national defense of the United [redacted] within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in [redacted]nner to an unauthorized person is prohibited by law.

TABLE VI

AZIMUTH UPDATE

Time (sec)	Flt Calc. Simulation	DELTA DELTA	IBM	Units
0	.0004264	.000176	.000176	radians
100	-.009244	-.009182	-.009257	radians
140	+.000164	0	+.000106	radians
Total (100 and 140)	-.009080 .52	-.009182 .525	-.009151 .525	radians degrees

The calculated update values show agreement to within the .1 fps velocity least count accuracy which is equivalent to .00008 radians. The values indicated at 100 seconds include those at 0 seconds. The value for zero seconds in the DELTA DELTA column is that of IBM.

The Z axis velocities at 100 and 140 seconds were determined from the MISTRAM I data and compared to the GE/Burroughs telemetered values. The MISTRAM velocities were 348.39 and 198.55 at 100 and 140 seconds, respectively, which are in good agreement with the GE/Burroughs values of 348.5 and 199.0 at the corresponding times. The net azimuth update corrections have been applied in all the plots included in this report.

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

The history of initial alignment error is

$$\text{GT-2} \quad \eta_x = -.29^\circ$$

$$\text{GT-3} \quad \eta_x = -.52^\circ$$

$$1\,\sigma(\text{specification}) \quad \eta_x = .25^\circ$$

It is understood that the major contribution to the specification value is due to the inaccuracy in slewing the platform to a new azimuth as a result of updating the Agena orbit. On these two non-rendezvous flights a fixed azimuth was flown and the misalignment angles reflect only the basic inability to align the inertial platform with the outside world, not the slewing error. Since the errors observed on these two flights are already as large or larger than would be expected, it appears that when the slewing error is added, the total alignment uncertainty will be considerably larger than the present specification value.

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

4.0 RE-ENTRY ANALYSIS

4.1 Introduction

Analysis of the IMU performance during re-entry was based primarily on position comparisons in re-entry guidance coordinates. The guidance coordinate system, during re-entry is defined by the DCS inserted state vector (spacecraft position and velocity) valid at the intended time of retrofire. The guidance X axis is directed along the total inertial velocity vector, the Y axis is positive downward along the position vector from the earth's center and the Z axis completes the right handed set.

The tracking data, available for the analyses, were obtained from four C-band tracking radars. These covered the time interval between 455 and 800 seconds after retrofire or the whole atmospheric re-entry period. The lack of tracking data prior to this interval limited the isolation of re-entry mode initialization errors. It is expected that this problem will be solved on future flights by the timely arrival of high rate tracking data during intervals just prior to and following retrofire.

The method used in the analyses consisted of computing the guidance thrust velocities, as was done during the ascent data reduction. A re-entry trajectory reconstruction program was then used to generate the S/C trajectory using the guidance system output. This program has the capability of adjusting thrust data for gravity to form total inertial positions and velocities. These quantities were then compared with radar data to form the comparisons shown in Figures 9 and 10.

4.2 Impact Point Determination

Table VII shows the spacecraft position at 798.9 seconds as indicated from PCM telemetry, radar, STL reconstructed guidance data, and the STL reconstructed trajectory using corrected guidance data (see Sections 4.3 and

5.0). The time chosen corresponds to the last available reconstructed trajectory data point. The intended impact point is also presented.

Table VII

INDICATED POSITION SUMMARY

	Deg. Latitude (Geocentric)	Deg. Latitude (Geodetic)	Deg. Long. (Geodetic)	Altitude (feet)
T = 798.9				
1. Radar (7:18)	22.364	22.499	-70.840	51148
2. Reconstructed Trajectory (Corrected)	22.373	22.508	-70.838	50270
3. Guidance Telemetry	22.355	22.490	-70.848	359
4. Reconstructed Trajectory (Uncorrected)	22.369	22.504	-70.880	12338
5. Intended Impact	21.89*	22.025	-69.88*	0

*Obtained from Canarvon MDIU print.

The corrected trajectory (2) which provides the best estimate of the spacecraft position indicates that the difference between the spacecraft position at 799 seconds and the intended impact was .483 degrees in latitude and -.958 degrees in longitude. The altitude at this time was 50,270 feet. This difference corresponds to the following:

POSITION ERROR AT 799 SECONDS RELATIVE TO INTENDED IMPACT

North	West	Downrange	Crossrange
29 ± .6 n.mi.	53 ± .2 n.mi.	59 n.mi. short	13.6 n.mi. left

The down and crossrange values are based upon a 115.7 degree heading from North which was that determined just prior to re-entry. The uncertainties assigned are combinations of the differences between the reconstructed trajectory and radar positions and rough estimates of radar accuracy.

The difference in Table VII between the reconstructed guidance (2) and the onboard computed value (3) is attributable to errors in either the airborne computations or the reconstruction initialization. Since the longitude difference was nearly constant over the entire time interval, an initialization error is suspected.

The altitude difference between the uncorrected sources (3 or 4) and the actual trajectory (1 or 2) is due primarily to the pitch error contained in the guidance data.

4.3 IMU Analysis

Figures 9 and 10 present comparisons of IGS data with positions and velocities obtained from the four radars. The following table gives the position and velocity errors at 455 and 800 seconds from retrofire as indicated by the comparisons. These times correspond approximately to the beginning and end of atmospheric re-entry (see Figure 21).

Figure 9

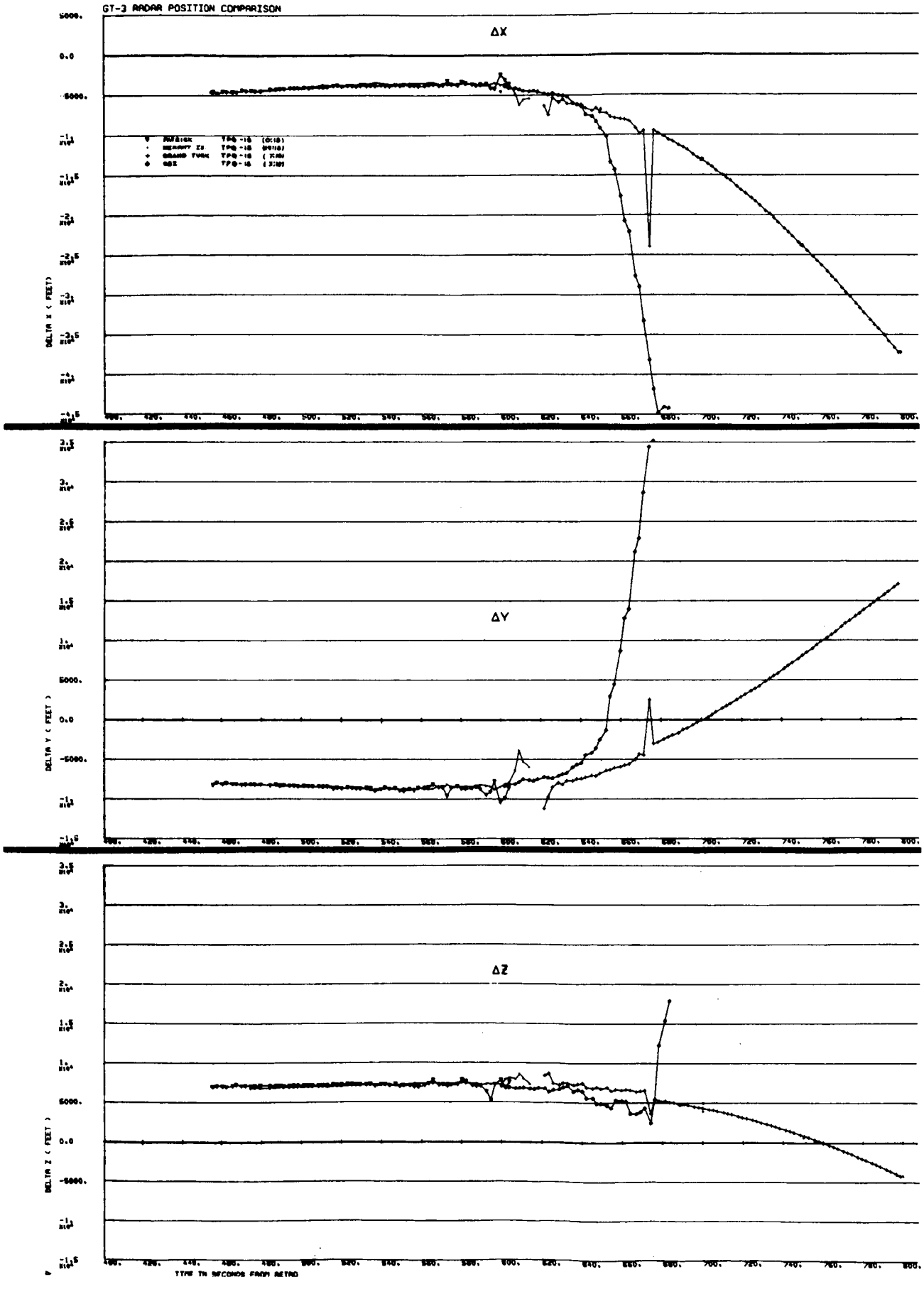
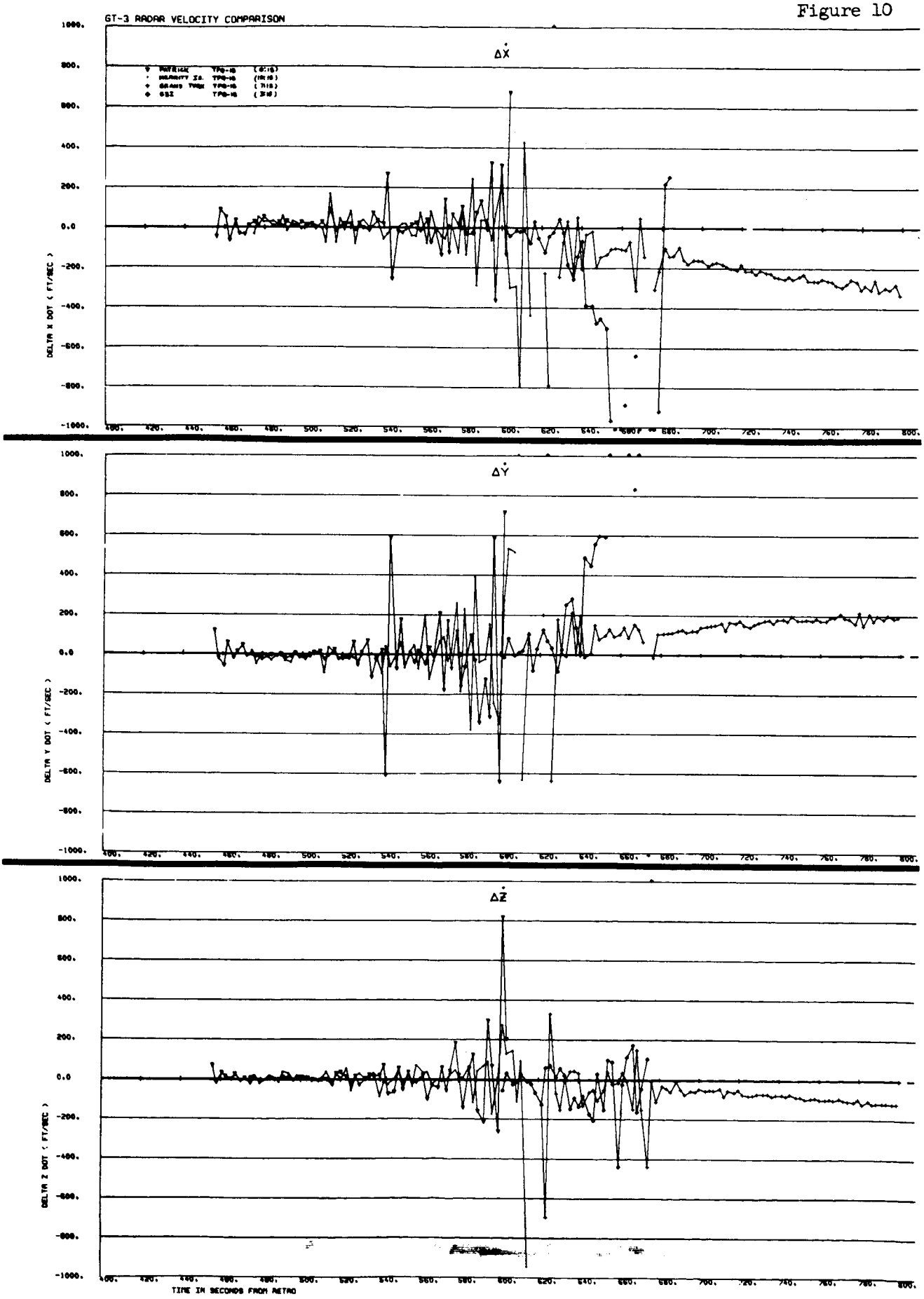

GT-3 RADAR POSITION COMPARISON
ΔX
ΔY
ΔZ
DELTA X (FEET)
DELTA Y (FEET)
DELTA Z (FEET)
TIME IN SECONDS FROM RETRO

Figure 10


GT-3 RADAR VELOCITY COMPARISON
ΔẊ
DELTA X DOT (FT/SEC)
ΔẎ
DELTA Y DOT (FT/SEC)
ΔŻ
DELTA Z DOT (FT/SEC)
TIME IN SECONDS FROM RETRO

INERTIAL GUIDANCE SYSTEM ERROR DURING RE-ENTRY

Time From Retrofire (sec)	Position (ft)			Velocity (ft/sec)		
	X	Y	Z	$\dot{X}$	$\dot{Y}$	$\dot{Z}$
455	-4750	-8000	+7000	9	-6.5	0
800	-37500	+17500	-4500	-300	200	-120

The major portion of the error indicated at 455 seconds is due to one or more of the following causes:

a. The initialization state vector, calculated on the ground and transmitted to the S/C is incorrect.

b. The platform is incorrectly aligned, leading to a directional error in the retromaneuver impulse.

c. There is a data processing error, the most likely of which is a time correlation error.

Figures 11 and 12 were obtained by initializing the guidance data, at the time of the first radar data point (455 seconds), with radar positions and velocities. These were generated in order to determine the secondary effects of initialization errors upon the gravity computations. Comparison of the data indicates that the secondary effects were minor relative to the total error.

Figure 11

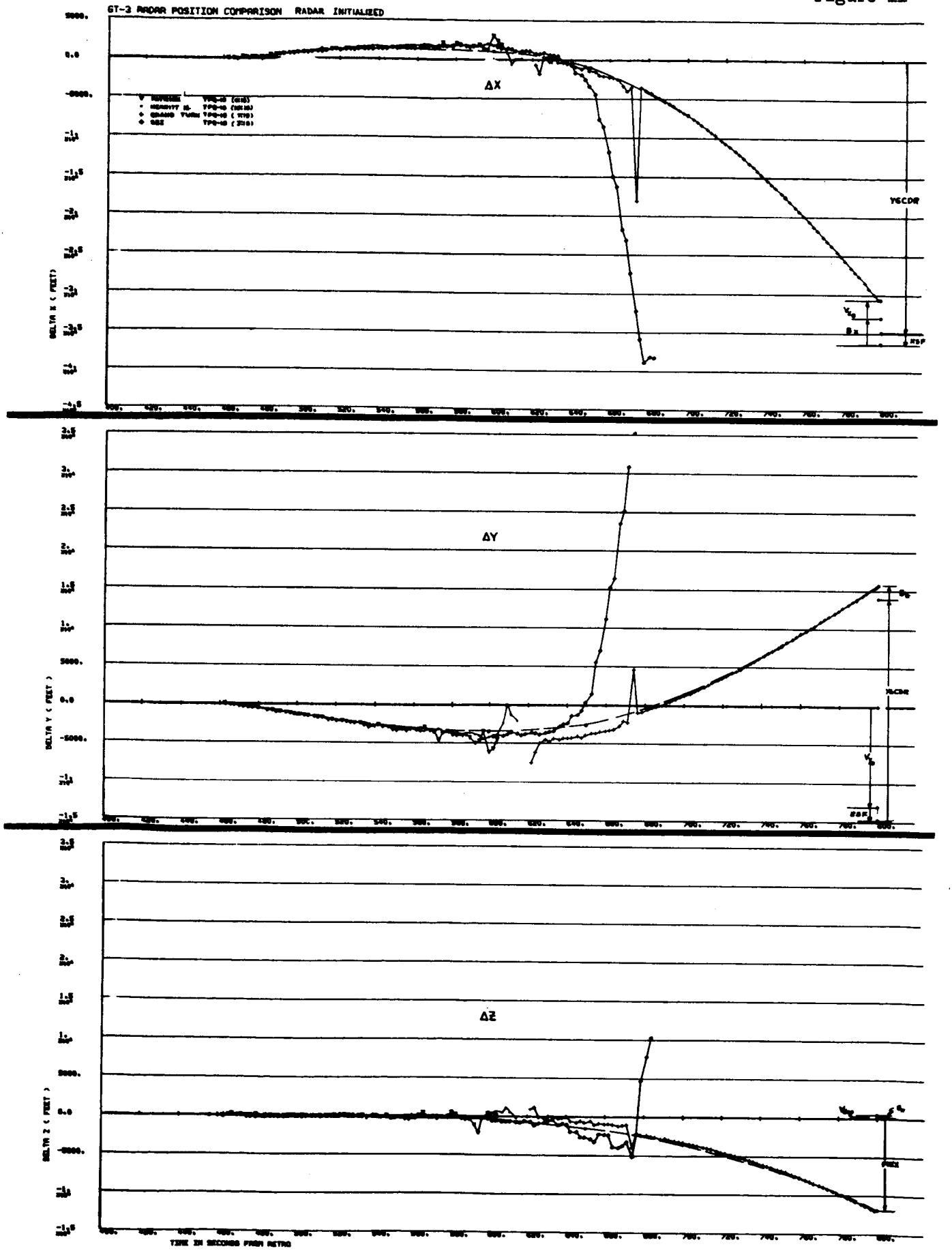
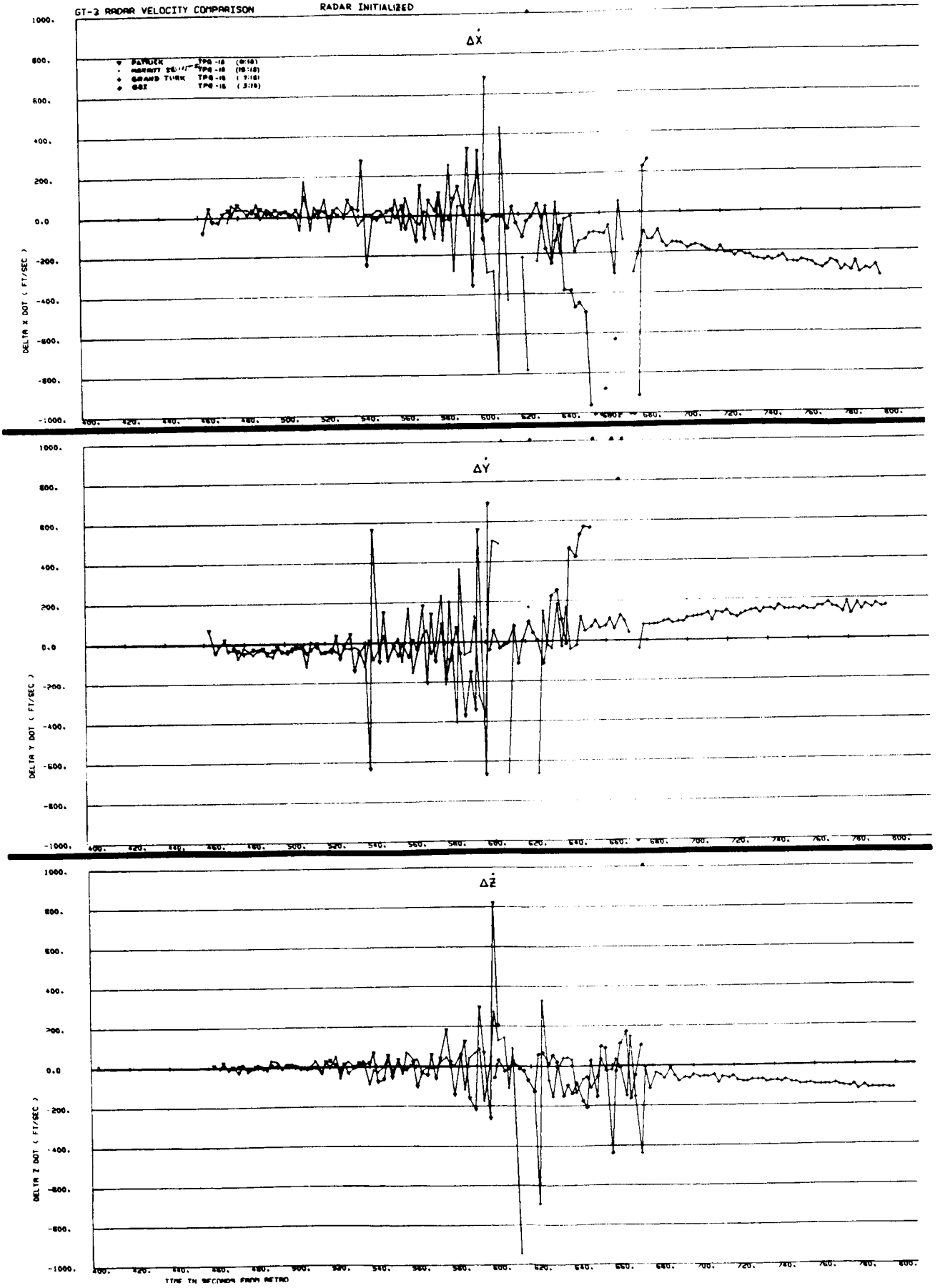

GT-3 RADAR POSITION COMPARISON RADAR INITIALIZED
ΔX
ΔY
ΔZ
DELTA X (FEET)
DELTA Y (FEET)
DELTA Z (FEET)
TIME IN SECONDS FROM RETRO

Figure 12


GT-3 RADAR VELOCITY COMPARISON
RADAR INITIALIZED
ΔẊ
DELTA X DOT (FT/SEC)
ΔẎ
DELTA Y DOT (FT/SEC)
ΔŻ
DELTA Z DOT (FT/SEC)
TIME IN SECONDS FROM RETRO

The manner in which the errors increase after 455 seconds is indicative of guidance system IMU and/or alignment errors. A pitch type error was suggested by the approximately asymetric X and Y position error propagations. The philosophy involved in isolating the major contributing error sources was to first extract, from the error curves, the effects of those IMU errors which were considered as "known". These consisted of accelerometer bias and Z accelerometer scale factor errors recovered from the ascent analysis and verified somewhat by the preflight calibration differences. A fit to the residual position error was then accomplished from which a -4.6 degree per hour Y gyro constant drift rate was recovered as the major pitch error. An alternate hand fit was accomplished which recovered an initial pitch misalignment of -2900 $\widehat{\text{sec}}$ as the major pitch error. Either of these recovered coefficients or combinations of the two could provide an explanation of the observed errors; however, isolation of the exact error source is difficult due to high correlation among error sources.

The drift rate error is considered the more probable because it and other recovered coefficients of the fit from which it was derived are somewhat closer in agreement with the ascent analysis results. The recovered coefficients from both fits are summarized in Table VIII.

Alternate fits were also accomplished for the Z axis error. However, both indicated a large initial platform misalignment about the X accelerometer axis as the major error source.

The fits to the re-entry data are tabulated in Table VIII. The coefficients labeled FIT 1 and FIT 2 are associated with the X and Y axes and those labeled FIT 3 and FIT 4 are associated with the Z axis error. The coefficient sets represented by FIT 1 and FIT 3 were used to compensate the IGS data for reconstruction of the re-entry trajectory. The position error propagation of these are shown as a dashed curve on the plots of Figure 11.

TABLE VIII

RE-ENTRY ANALYSIS RECOVERED ERROR SOURCE COEFFICIENTS

(1) X and Y Axis Error Source		FIT 1	FIT 2	UNITS
(A) Knowns from Ascent Analysis				
X accelerometer bias	(BX)	340	340	ppm g
Z accelerometer bias	(BZ)	180	180	ppm g
Z accelerometer scale factor	(ZSF)	611	611	ppm
(B) Recovered From Re-Entry Analysis				
Y gyro constant drift rate	(YGCDR)	-4.59	-	deg/hr
Platform misalignment about Y accelerometer axis	(PHIY)	-	-2920	$\widehat{sec}$
X accel scale factor	(XSF)	712	455	ppm
Initial Errors at Retro				
X guidance position	(XO)	-7816	-7870	ft
Y guidance position	(YO)	-4475	-4475	ft
X guidance velocity	(V_{XO})	4.8	3.7	fps
Y guidance velocity	(V_{YO})	-9.1	-5.2	fps

(2) Z Axis Error Source		FIT 3	FIT 4	UNITS
(A) Known From Ascent Ascent Analysis				
Y accelerometer bias	(BY)	-22	-22	ppm g
(B) Recovered from Re-Entry Analysis				
Platform misalignment about X accelerometer axis	(PHIX)	-1080	-886	$\widehat{sec}$
Platform misalignment about Z accelerometer axis	(PHIZ)	-	200	$\widehat{sec}$
Initial Errors at Retro				
Z position	(ZO)	4443	4443	ft
Z velocity	(V_{ZO})	-4.74	-4.74	fps

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U.S.C., Section 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

5.0 TRAJECTORY RECONSTRUCTION

This section provides a trajectory reconstruction for ascent from liftoff to 370 seconds (11 seconds after separation) and for re-entry from 462 seconds to 799 seconds after retro (16865 to 17202 seconds after liftoff).

The data is provided in an ECIG coordinate system which is a right-handed inertial Cartesian coordinate system with the origin at the center of the earth. The Z axis is the North polar axis, the X-Y plane is the equatorial plane with the X-Z plane containing the Greenwich meridian at Go Inertial (14^h 23^m 56.612^s) time for the ascent segment, and time of retrofire (18^h 47^m 47.612^s GMT) for re-entry.

The ascent reconstruction consists of corrected guidance data from 0 to 86.687 seconds and quick look 100K MISTRAM data from 89.109 until 369.765 seconds. Section 3.0 provides a description of the corrections that were applied to the guidance data.

The re-entry reconstruction was derived from corrected guidance data. Section 4.0 provides a description of the corrections applied. Special parameters are also provided for the re-entry trajectory reconstruction. These consist of velocity magnitude, relative flight path angle, altitude and geodetic latitude and longitude. The first three special parameters are plotted in Figure 13.

ASCENT TRAJECTORY RECONSTRUCTION

TIME IN SECONDS FROM LIFTOFF

TIME	X	Y	Z	X-DOT	Y-DOT	Z-DOT
2.484	3027992	-18152002	9927987	1326.885	200.566	11.306
4.781	3031043	-18151565	9928026	1329.632	180.405	22.484
7.515	3034634	-18151105	9928107	1333.128	155.342	36.873
9.812	3037749	-18150774	9928206	1336.440	133.107	49.839
12.124	3040843	-18150493	9928337	1339.448	109.718	63.216
14.437	3043945	-18150267	9928499	1342.911	85.502	77.408
16.765	3047075	-18150096	9928696	1346.206	60.717	92.016
19.515	3050783	-18149973	9928975	1350.387	29.136	110.694
21.828	3053909	-18149937	9929249	1354.248	1.853	127.177
24.093	3056981	-18149964	9929556	1358.389	-26.010	144.062
26.499	3060257	-18150063	9929925	1365.822	-56.110	162.950
28.906	3063556	-18150235	9930342	1377.088	-86.521	183.594
31.296	3066867	-18150478	9930808	1392.539	-117.188	206.232
33.703	3070241	-18150797	9931332	1412.670	-147.999	229.416
36.109	3073667	-18151191	9931913	1436.096	-179.037	253.860
38.484	3077109	-18151653	9932546	1463.448	-210.169	279.889
40.874	3080645	-18152192	9933248	1495.249	-241.092	307.595
43.265	3084262	-18152805	9934018	1531.444	-271.128	336.416
45.624	3087922	-18153480	9934846	1571.629	-301.384	366.372
48.015	3091731	-18154237	9935761	1615.514	-331.603	398.507
50.390	3095624	-18155061	9936747	1663.508	-362.117	432.189
52.749	3099609	-18155951	9937806	1715.720	-392.065	466.087
55.124	3103751	-18156917	9938954	1772.590	-421.135	500.577
57.499	3108033	-18157951	9940189	1834.178	-448.922	539.479
59.906	3112527	-18159061	9941534	1901.784	-473.994	578.603
62.281	3117129	-18160214	9942956	1973.939	-497.443	618.990
64.687	3121970	-18161439	9944494	2051.107	-519.616	660.155
72.343	3138691	-18165689	9950053	2325.759	-588.052	795.163
74.718	3144329	-18167106	9951995	2422.123	-605.243	841.046
77.093	3150201	-18168564	9954047	2523.341	-621.711	888.867
79.484	3156357	-18170069	9956235	2627.766	-637.121	942.364
81.890	3162808	-18171619	9958576	2735.290	-650.043	1002.538
84.281	3169480	-18173186	9961051	2847.167	-661.448	1067.712
86.687	3176471	-18174789	9963700	2965.124	-670.829	1134.754

TIME IN SECONDS FROM LIFTOFF

TIME	X	Y	Z	X-DOT	Y-DOT	Z-DOT
89.109	3183635	-18176355	9966505	3090.277	-679.161	1203.650
91.515	3191226	-18177999	9969487	3219.434	-686.421	1275.146
93.937	3199186	-18179670	9972665	3355.215	-693.305	1349.392
96.343	3207428	-18181347	9976003	3496.326	-700.193	1424.980
98.187	3213977	-18182641	9978684	3608.523	-703.706	1484.320
100.609	3222901	-18184350	9982375	3761.970	-707.851	1563.739
103.031	3232205	-18186067	9986261	3922.407	-709.511	1645.516
105.437	3241842	-18187775	9990319	4089.211	-709.278	1728.228
107.874	3252022	-18189504	9994636	4263.927	-710.143	1814.295
110.296	3262565	-18191226	9999137	4443.830	-711.495	1902.349
112.703	3273482	-18192936	10003820	4632.099	-709.267	1990.389
115.124	3284939	-18194645	10008749	4830.472	-701.387	2080.419
117.531	3296808	-18196319	10013865	5036.057	-689.265	2172.344
119.953	3309264	-18197970	10019241	5251.440	-673.371	2267.675
122.374	3322251	-18199579	10024853	5475.004	-654.238	2367.101
124.781	3335701	-18201129	10030671	5705.528	-634.446	2469.348
127.203	3349809	-18202641	10036780	5946.483	-613.630	2576.340
129.624	3364512	-18204101	10043153	6196.803	-591.745	2687.034
132.031	3379732	-18205497	10049755	6455.401	-568.715	2801.181
134.453	3395692	-18206846	10056683	6726.578	-544.517	2920.578
136.874	3412324	-18208134	10063905	7009.513	-518.945	3044.758
139.281	3429541	-18209350	10071386	7303.112	-491.903	3173.402
141.703	3447599	-18210508	10079234	7611.552	-463.391	3308.612
144.124	3466422	-18211594	10087416	7934.751	-433.272	3449.806
146.562	3486175	-18212610	10096005	8275.750	-400.567	3598.664
148.968	3506509	-18213533	10104848	8628.445	-365.902	3752.379
152.798	3540668	-18214820	10119702	9159.232	-301.524	3977.606
153.812	3549965	-18215112	10123734	9182.355	-275.256	3976.840
156.187	3571867	-18215695	10133187	9262.441	-215.075	3983.901
158.593	3594254	-18216138	10142783	9345.365	-153.133	3992.048
160.999	3616843	-18216431	10152399	9430.332	-90.455	4000.459
163.390	3639490	-18216572	10161973	9516.754	-27.299	4009.273
165.765	3662196	-18216562	10171506	9604.327	35.720	4018.702
168.093	3684658	-18216407	10180874	9691.674	97.293	4028.571

CONFIDENTIAL

CONFIDENTIAL

TIME IN SECONDS FROM LIFTOFF

TIME	X	Y	Z	X-DOT	Y-DOT	Z-DOT
170.499	3708089	-18216096	10190580	9783.346	161.226	4039.317
172.906	3731743	-18215626	10200311	9877.588	231.542	4047.922
175.312	3755626	-18214975	10210058	9974.125	311.052	4052.810
177.718	3779744	-18214121	10219812	10071.872	400.124	4053.577
180.124	3804098	-18213042	10229562	10170.208	498.447	4049.890
182.593	3829330	-18211676	10239551	10270.721	609.540	4041.100
185.046	3854648	-18210039	10249449	10370.578	725.876	4029.167
187.515	3880375	-18208100	10259381	10472.015	845.195	4016.686
189.187	3897941	-18206619	10266089	10541.427	926.693	4008.321
191.640	3923926	-18204198	10275907	10644.402	1047.111	3996.173
194.109	3950334	-18201462	10285758	10749.454	1169.083	3984.348
196.562	3976833	-18198445	10295518	10855.305	1291.061	3973.044
199.015	4003594	-18195128	10305251	10962.791	1413.507	3962.301
201.484	4030794	-18191485	10315021	11072.707	1537.536	3952.072
203.937	4058092	-18187562	10324704	11183.698	1661.060	3942.559
206.406	4085842	-18183307	10334426	11297.188	1785.930	3933.645
208.874	4113874	-18178744	10344127	11412.567	1911.392	3925.315
211.328	4142013	-18173901	10353746	11529.110	2036.661	3917.677
213.796	4170622	-18168717	10363409	11648.389	2163.297	3910.616
216.249	4199344	-18163255	10372995	11769.007	2289.959	3904.148
218.718	4228551	-18157444	10382626	11892.482	2418.006	3898.336
220.406	4248692	-18153289	10389201	11978.159	2506.026	3894.670
222.874	4278419	-18146942	10398810	12105.351	2635.573	3889.763
225.328	4308273	-18140318	10408347	12234.014	2764.930	3885.528
227.796	4338638	-18133331	10417934	12366.023	2895.983	3881.893
230.265	4369332	-18126019	10427514	12500.617	3027.801	3878.851
232.718	4400164	-18118430	10437026	12636.878	3159.753	3876.343
235.187	4431533	-18110464	10446593	12776.500	3293.577	3874.475
237.640	4463048	-18102220	10456096	12917.785	3427.715	3873.111
240.109	4495117	-18093590	10465657	13062.676	3564.321	3872.208
242.562	4527341	-18084678	10475155	13209.395	3701.594	3871.886
245.031	4560137	-18075367	10484714	13359.904	3841.359	3871.979
247.484	4593097	-18065772	10494213	13512.431	3981.919	3872.702
249.171	4615989	-18058970	10500749	13619.054	4079.470	3873.436

TIME IN SECONDS FROM LIFTOFF

TIME	X	Y	Z	X-DOT	Y-DOT	Z-DOT
251.640	4649806	-18048721	10510313	13777.758	4223.989	3875.045
254.093	4683801	-18038181	10519822	13938.727	4369.149	3877.224
256.562	4718416	-18027212	10529397	14104.122	4517.642	3880.002
259.015	4753221	-18015947	10538920	14272.053	4666.692	3883.622
261.484	4788667	-18004239	10548513	14444.551	4818.799	3887.968
263.953	4824544	-17992153	10558117	14621.113	4972.785	3893.046
266.406	4860631	-17979764	10567674	14800.589	5127.943	3898.932
268.874	4897397	-17966910	10577308	14985.450	5286.177	3905.758
271.328	4934388	-17953746	10586898	15173.566	5446.037	3913.366
273.796	4972086	-17940101	10596570	15367.515	5608.674	3922.154
276.249	5010026	-17926141	10606203	15565.211	5773.287	3931.731
278.718	5048704	-17911682	10615923	15769.384	5941.156	3942.758
280.390	5075186	-17901653	10622521	15910.810	6056.370	3950.927
282.859	5114728	-17886490	10632292	16124.452	6228.372	3964.213
285.312	5154550	-17870999	10642034	16342.787	6401.707	3978.919
287.781	5195174	-17854976	10651877	16568.771	6579.732	3994.966
290.234	5236102	-17838615	10661698	16800.054	6759.420	4012.424
292.687	5277605	-17821809	10671564	17038.493	6942.629	4031.559
295.124	5319433	-17804661	10681416	17282.868	7127.948	4052.409
297.562	5361866	-17787059	10691321	17535.195	7316.168	4074.956
299.984	5404645	-17769106	10701218	17793.932	7508.696	4098.710
302.343	5446934	-17751165	10710917	18054.495	7700.758	4123.436
304.656	5488988	-17733136	10720483	18318.553	7892.542	4149.750
306.968	5531664	-17714657	10730111	18591.670	8089.326	4177.957
309.281	5574983	-17695718	10739807	18874.566	8291.559	4207.915
312.328	5633078	-17670042	10752694	19263.106	8565.054	4251.331
314.640	5677978	-17649987	10762565	19571.225	8781.103	4286.505
316.937	5723294	-17629568	10772454	19889.937	8997.747	4325.673
319.249	5769674	-17608502	10782506	20224.167	9224.165	4367.690
321.578	5817164	-17586751	10792726	20575.512	9459.753	4413.167
323.874	5864837	-17564753	10802919	20938.058	9697.551	4462.782
326.187	5913694	-17542042	10813300	21320.131	9946.352	4516.316
328.499	5963457	-17518747	10823811	21720.689	10204.293	4573.874
330.812	6014168	-17494838	10834457	22141.975	10471.628	4636.126

CONFIDENTIAL

GEMINI TRAJECTORY IN ECIG

TIME IN SECONDS FROM LIFTOFF

TIME	X	Y	Z	X-DOT	Y-DOT	Z-DOT
333.998	6085685	-17460860	10349374	22734.016	10858.632	4736.303
336.187	6135479	-17437029	10859701	22746.650	10918.350	4637.050
338.703	6192683	-17409476	10871469	22730.853	10982.840	4660.210
340.828	6240969	-17386072	10881334	22715.718	11035.290	4628.967
343.343	6298087	-17358220	10892925	22695.220	11100.823	4589.737
347.984	6403313	-17306420	10914049	22653.730	11226.987	4512.082
350.499	6460276	-17278123	10925361	22633.502	11271.120	4480.318
353.015	6517182	-17249678	10936576	22606.751	11344.092	4436.857
355.249	6567673	-17224252	10946443	22587.259	11404.117	4399.545
357.656	6621996	-17196740	10956984	22564.495	11463.536	4362.185
362.499	6731176	-17140915	10977915	22512.619	11610.074	4269.463
364.921	6785679	-17112794	10988243	22490.562	11659.948	4235.637
359.765	6894506	-17056053	11008588	22440.515	11794.488	4152.201

RE-ENTRY TRAJECTORY RECONSTRUCTION

GEMINI GT-3 FREE FLIGHT AND REENTRY RECONSTRUCTION

EARTH CENTERED INERTIAL GREENWICH COORDINATE SYSTEM

TIME (SEC)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)
462.4[illegible]	2374275.00	-18613390.00	9838713.00	24377.34	14.53	-7233.43
465.3275	2443579.87	-18613290.25	9818115.37	24364.56	55.56	-7252.75
467.2494	2490393.84	-18613133.25	9804151.00	24352.42	107.78	-7279.31
470.0932	2559618.91	-18612717.75	9783395.00	24333.35	184.51	-7318.35
472.0150	2606371.50	-18612313.00	9769304.75	24319.76	236.58	-7344.60
474.8588	2675501.28	-18611531.25	9748363.25	24298.99	313.20	-7383.51
476.7807	2722186.66	-18610879.75	9734148.12	24284.16	364.86	-7409.48
479.6244	2791211.87	-18609733.25	9713022.75	24261.06	441.45	-7447.89
484.4057	2907110.81	-18607316.75	9677261.75	24219.55	569.42	-7510.94
487.2338	2975568.75	-18605600.00	9655967.75	24192.68	644.60	-7547.87
489.1713	3022423.37	-18604301.00	9641319.50	24173.39	696.30	-7572.87
491.1713	3070749.56	-18602855.25	9626147.87	24152.79	749.52	-7598.76
494.2494	3145043.66	-18600422.75	9602698.00	24119.52	830.99	-7637.67
496.3275	3195142.91	-18598639.00	9586799.12	24096.29	885.61	-7663.58
498.4213	3245569.37	-18596727.50	9570726.50	24072.29	940.31	-7689.30
501.4994	3319608.91	-18593709.00	9547000.37	24034.62	1021.00	-7726.68
503.5775	3369528.19	-18591530.75	9530917.75	24007.99	1075.20	-7751.34
505.6557	3419391.09	-18589240.25	9514784.37	23980.39	1129.16	-7775.47
508.7338	3493139.22	-18585642.25	9490796.50	23937.16	1208.61	-7810.60
510.8275	3543224.72	-18583055.75	9474418.00	23905.72	1262.20	-7834.45
512.9057	3592869.84	-18580377.25	9458113.25	23873.03	1315.70	-7857.34
515.9838	3666274.16	-18576208.00	9433876.87	23821.15	1393.23	-7890.20
518.0775	3716110.50	-18573235.75	9417334.37	23783.72	1445.77	-7911.58
520.1557	3765495.75	-18570177.25	9400871.37	23744.93	1497.81	-7932.47
523.2182	3838121.94	-18565474.50	9376533.50	23684.42	1573.45	-7961.70
525.3119	3887665.41	-18562127.00	9359843.50	23640.69	1624.15	-7981.01
527.3900	3936747.00	-18558699.25	9343238.87	23595.75	1674.60	-7999.39
529.4682	3985733.62	-18555167.50	9326596.87	23549.25	1724.54	-8016.91
532.5463	4058109.31	-18549747.25	9301881.62	23476.58	1797.15	-8041.76

GEMINI GT-3 FREE FLIGHT AND REENTRY RECONSTRUCTION

EARTH CENTERED INERTIAL GREENWICH
COORDINATE SYSTEM

TIME (SEC)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)
534.6244	4106843.03	-18545961.50	9285153.50	23425.03	1846.41	-8057.40
536.7025	4155467.75	-18542074.50	9268393.62	23371.69	1894.30	-8072.47
539.7963	4227645.69	-18536104.50	9243387.00	23288.81	1965.15	-8093.40
541.8744	4275981.25	-18531971.75	9226554.75	23229.61	2012.14	-8106.01
543.9525	4324190.56	-18527742.50	9209694.87	23167.37	2058.09	-8120.12
547.0463	4395710.06	-18521270.75	9184548.87	23067.47	2125.69	-8135.87
549.1244	4443573.56	-18516807.50	9167631.25	22996.66	2169.71	-8145.70
551.2025	4491286.75	-18512254.25	9150695.00	22922.79	2212.54	-8153.83
554.2963	4562024.44	-18505310.75	9125453.37	22806.64	2276.21	-8164.03
556.3900	4609690.06	-18500501.75	9108353.12	22724.66	2317.26	-8170.57
558.4682	4656825.81	-18495642.75	9091370.12	22639.11	2359.14	-8173.95
561.5463	4726309.50	-18488293.50	9066199.87	22507.64	2416.08	-8180.27
563.6400	4773335.50	-18483194.50	9049072.25	22412.70	2454.44	-8180.47
565.7182	4819807.62	-18478055.00	9032071.00	22312.34	2491.96	-8181.70
568.7963	4888247.75	-18470302.50	9006890.62	22156.40	2545.26	-8179.11
570.8900	4934523.31	-18464937.75	8989769.50	22047.13	2579.12	-8175.40
572.9838	4980565.19	-18459501.75	8972658.25	21933.17	2613.57	-8169.65
575.0619	5026024.75	-18454039.75	8955689.62	21817.39	2643.01	-8161.06
578.1400	5092904.62	-18445832.25	8930591.50	21637.53	2689.75	-8146.34
580.2182	5137737.19	-18440212.25	8913673.12	21509.60	2719.09	-8136.01
582.2963	5182301.31	-18434533.75	8896780.50	21379.20	2746.04	-8121.66
585.3744	5247799.75	-18426019.50	8871814.25	21178.14	2786.02	-8100.02
587.4682	5291991.87	-18420156.00	8854871.37	21035.25	2814.96	-8084.17
589.5463	5335554.62	-18414282.50	8838086.87	20889.82	2837.62	-8069.34
592.6244	5399506.56	-18405488.75	8813293.62	20662.72	2876.11	-8039.99
594.7025	5442279.12	-18399489.00	8796608.50	20501.85	2898.14	-8017.87
596.7807	5484712.00	-18393444.00	8779970.25	20335.77	2919.46	-7994.97
599.8588	5546916.56	-18384416.75	8755426.62	20081.43	2945.98	-7952.11
601.9525	5588776.69	-18378233.50	8738814.00	19904.35	2960.43	-7916.66

EARTH CENTERED INERTIAL GREENWICH
COORDINATE SYSTEM

TIME (SEC)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)
604.0150	5629643.69	-18372116.25	8722525.75	19724.22	2971.42	-7878.00
607.1088	5690240.50	-18362897.75	8698254.25	19449.48	2988.01	-7812.65
609.1869	5730459.94	-18356679.25	8682068.87	19257.95	2996.85	-7764.35
611.2650	5770278.31	-18350443.75	8665984.75	19063.49	3004.16	-7715.03
614.3432	5828505.94	-18341180.75	8642358.87	18769.69	3014.46	-7635.82
616.4213	5867300.56	-18334911.75	8626550.62	18566.52	3018.81	-7578.16
618.4994	5905668.31	-18328633.75	8610865.75	18358.82	3023.17	-7517.00
621.5775	5961699.50	-18319321.50	8587875.37	18047.22	3027.47	-7420.92
623.6557	5998981.87	-18313027.75	8572525.37	17833.62	3029.66	-7352.05
625.7338	6035818.25	-18306728.25	8557321.37	17617.91	3032.94	-7280.38
628.7963	6089278.75	-18297436.25	8535195.37	17295.05	3035.31	-7169.21
630.8744	6124990.69	-18291129.75	8520379.37	17074.36	3034.31	-7089.87
632.9525	6160239.37	-18284822.00	8505729.50	16849.20	3036.11	-7009.16
636.0150	6211327.94	-18275529.50	8484460.12	16514.76	3032.57	-6881.10
638.0932	6245405.75	-18269229.00	8470249.00	16281.89	3031.06	-6795.79
640.1713	6278996.44	-18262934.75	8456213.50	16046.00	3026.54	-6711.96
642.2494	6312096.31	-18256653.00	8442351.25	15809.57	3019.03	-6629.16
645.3275	6360214.00	-18247374.25	8422132.00	15454.70	3009.73	-6508.26
647.4057	6392083.81	-18241130.25	8408694.12	15216.97	2999.75	-6424.40
649.4838	6423460.94	-18234907.00	8395433.00	14980.61	2989.54	-6338.24
652.5619	6469026.19	-18225718.00	8376128.56	14625.23	2980.88	-6204.75
654.6244	6498943.31	-18219581.50	8363428.62	14385.33	2969.64	-6110.30
656.7025	6528586.94	-18213422.25	8350831.44	14143.86	2958.16	-6013.31
659.7807	6571562.00	-18204337.00	8332544.06	13779.03	2944.97	-5868.84
661.8588	6599937.19	-18198229.75	8320454.37	13529.41	2932.68	-5766.40
663.9213	6627583.62	-18192195.25	8308666.81	13279.26	2918.79	-5663.95
666.9994	6667881.19	-18183245.50	8291466.25	12903.94	2896.28	-5512.03
669.0775	6694435.12	-18177239.75	8280122.12	12651.69	2883.75	-5405.64
671.1400	6720270.37	-18171305.25	8269083.37	12400.72	2870.94	-5298.62

GEMINI GT-3 FREE FLIGHT AND REENTRY RECONSTRUCTION

EARTH CENTERED INERTIAL GREENWICH COORDINATE SYSTEM

TIME (SEC)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)
674.2182	6757861.56	-18162510.00	8253009.31	12024.01	2843.70	-5145.41
676.2963	6782581.44	-18156620.25	8242420.94	11766.53	2824.64	-5044.92
678.3744	6806764.75	-18150770.00	8232040.81	11507.62	2805.75	-4944.95
681.4369	6841422.62	-18142224.00	8217126.06	11126.11	2775.24	-4795.33
683.5150	6864278.69	-18136477.25	8207271.87	10870.72	2755.50	-4688.40
685.5932	6886605.06	-18130771.25	8197642.56	10616.29	2736.01	-4578.90
688.6557	6918540.62	-18122440.50	8183865.19	10239.60	2704.42	-4418.58
690.7494	6939710.75	-18116802.75	8174727.50	9982.60	2681.00	-4309.92
692.8119	6960035.19	-18111299.25	8165952.75	9725.95	2655.71	-4198.93
695.8900	6989379.44	-18103189.00	8153271.81	9340.34	2613.94	-4040.46
697.9682	7008513.06	-18097790.25	8144986.12	9073.96	2581.86	-3933.77
700.0463	7027094.69	-18092458.75	8136919.25	8809.11	2549.21	-3829.87
703.1244	7053612.81	-18084684.75	8125379.12	8420.93	2501.81	-3668.28
705.2025	7070839.37	-18079518.50	8117873.06	8158.02	2470.19	-3555.57
707.2807	7087520.62	-18074417.75	8110605.75	7896.17	2439.04	-3438.50
710.3432	7111116.69	-18067018.25	8100342.12	7513.49	2393.15	-3264.28
712.4213	7126462.62	-18062077.75	8093681.62	7255.53	2361.81	-3145.88
714.4838	7141162.00	-18057240.50	8087318.50	6998.44	2328.65	-3024.38
717.5619	7162130.81	-18050145.25	8078277.75	6625.99	2281.61	-2849.84
719.6400	7175643.00	-18045436.25	8072481.00	6378.20	2250.20	-2728.96
721.7182	7188645.94	-18040790.00	8066933.44	6135.89	2221.48	-2610.05
724.7963	7206989.50	-18034014.75	8059163.94	5782.79	2180.65	-2438.15
726.8744	7218762.81	-18029508.50	8054218.00	5547.89	2156.24	-2321.87
728.9525	7230048.06	-18025051.75	8049511.00	5313.11	2133.04	-2208.16
732.0307	7245879.06	-18018536.75	8042956.50	4973.01	2099.95	-2050.58
734.1088	7255982.00	-18014193.75	8038796.06	4750.12	2079.77	-1953.48
736.1869	7265628.37	-18009891.50	8034832.50	4533.63	2060.96	-1861.09
738.2650	7274835.44	-18005633.25	8031063.75	4327.30	2037.14	-1765.96
741.3432	7287708.37	-17999455.25	8025832.06	4036.84	1976.89	-1633.33

GEMINI GT-3 FREE FLIGHT AND REENTRY RECONSTRUCTION

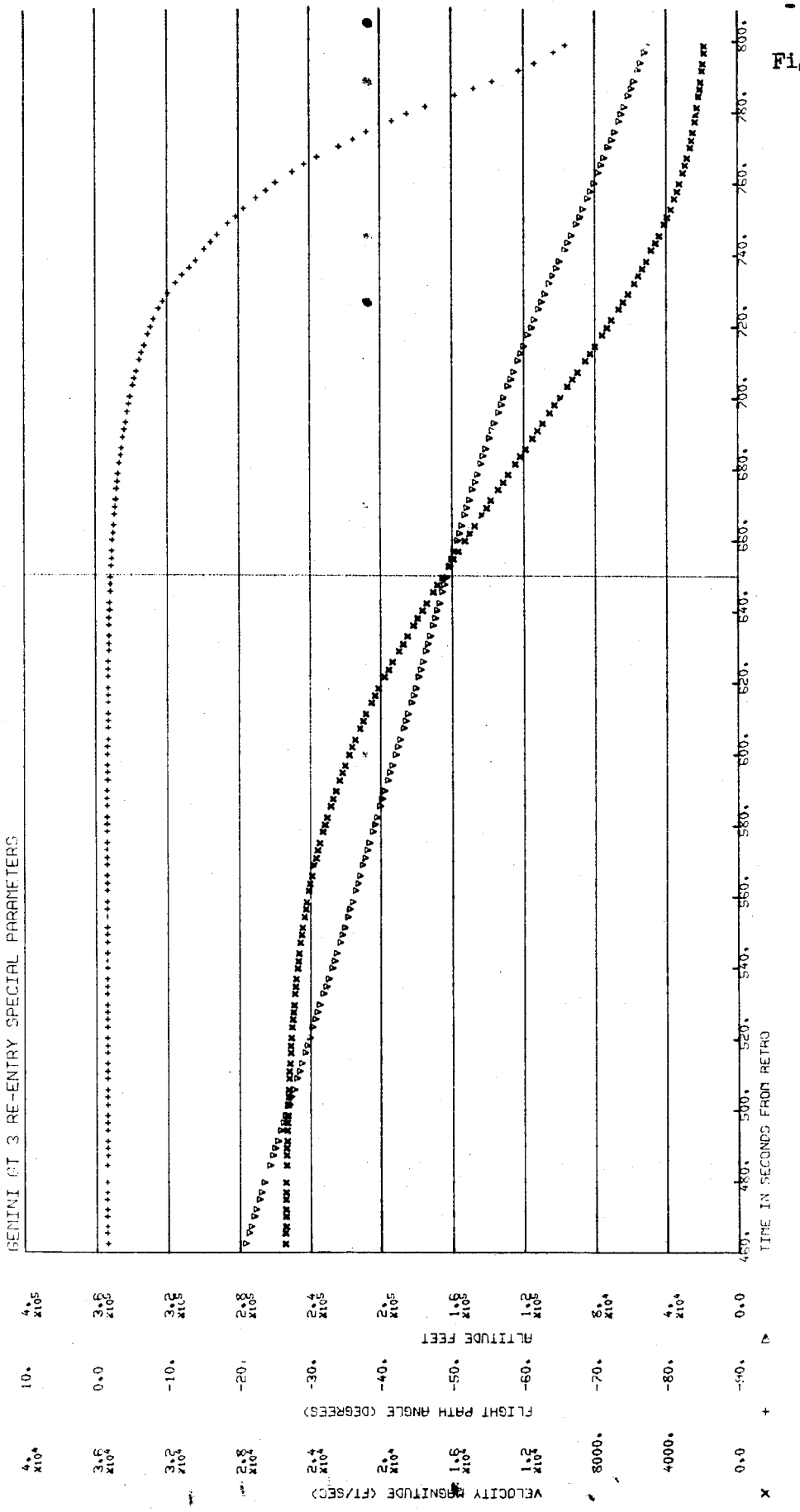
EARTH CENTERED INERTIAL GREENWICH
COORDINATE SYSTEM

TIME (SEC)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)
743.4057	7295839.37	-17995427.00	8022549.12	3847.77	1929.40	-1550.11
745.4994	7303701.81	-17991438.75	8019380.62	3662.63	1880.37	-1476.48
748.5775	7314570.25	-17985754.75	8015006.00	3399.06	1812.70	-1365.94
750.6557	7321462.44	-17982035.00	8012242.62	3234.03	1767.36	-1293.53
752.7338	7328024.06	-17978403.50	8009626.00	3080.92	1727.42	-1224.71
755.8119	7337185.69	-17973172.25	8006019.81	2871.84	1671.61	-1118.42
757.8900	7343014.75	-17969735.25	8003760.44	2738.09	1636.29	-1056.04
759.9682	7348577.44	-17966370.75	8001627.62	2615.44	1601.72	-996.54
763.0463	7356362.44	-17961507.00	7998699.81	2442.85	1558.36	-905.81
765.1244	7361326.06	-17958299.00	7996874.25	2334.15	1529.07	-851.10
767.1713	7366001.06	-17955198.00	7995184.00	2233.80	1500.90	-800.49
770.2182	7372597.44	-17950679.25	7992857.19	2096.12	1465.30	-726.82
772.2807	7376833.62	-17947679.25	7991400.06	2011.75	1443.82	-686.15
774.3432	7380907.00	-17944724.25	7990025.81	1938.17	1421.69	-646.49
777.3744	7386615.31	-17940458.00	7988150.06	1828.12	1393.19	-591.10
779.4369	7390321.81	-17937608.50	7986960.50	1766.06	1369.89	-562.45
781.4994	7393893.87	-17934809.00	7985819.06	1697.78	1344.85	-544.41
784.5307	7398902.44	-17930768.50	7984224.62	1606.83	1320.89	-507.58
786.5932	7402158.62	-17928074.00	7983193.81	1550.68	1292.02	-491.94
788.6557	7405305.37	-17925428.75	7982194.75	1500.76	1273.16	-476.87
791.7025	7409777.69	-17921584.75	7980772.44	1434.91	1249.98	-456.74
793.7650	7412698.75	-17919026.00	7979941.69	1397.58	1231.45	-445.80
796.7963	7416869.62	-17915339.25	7978518.56	1354.35	1201.06	-427.20
798.8588	7419638.06	-17912880.50	7977651.19	1330.20	1182.95	-413.86

RE-ENTRY TRAJECTORY RECONSTRUCTION

SPECIAL PARAMETERS

Figure 13


GEMINI GT 3 RE-ENTRY SPECIAL PARAMETERS
TIME IN SECONDS FROM RETRO
460. 480. 500. 520. 540. 560. 580. 600. 620. 640. 660. 680. 700. 720. 740. 760. 780. 800.
VELOCITY MAGNITUDE (FT/SEC)
4. x10⁴ 3.6 x10⁴ 3.2 x10⁴ 2.8 x10⁴ 2.4 x10⁴ 2. x10⁴ 1.6 x10⁴ 1.2 x10⁴ 8000. 4000. 0.0
FLIGHT PATH ANGLE (DEGREES)
10. 0.0 -10. -20. -30. -40. -50. -60. -70. -80. -90.
ALTITUDE FEET
4. x10⁵ 3.6 x10⁵ 3.2 x10⁵ 2.8 x10⁵ 2.4 x10⁵ 2. x10⁵ 1.6 x10⁵ 1.2 x10⁵ 8. x10⁴ 4. x10⁴ 0.0
+
Δ
X

TIME (SEC)	VELOCITY MAGNITUDE (FT/SEC)	FLIGHT PATH ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
462.4838	25427.9	-1.5198	276605.5	27.8281	-84.6630
465.3275	25421.2	-1.4246	274781.5	27.7675	-84.4651
467.2494	25417.3	-1.4272	273586.5	27.7264	-84.3314
470.0932	25410.7	-1.4302	271815.7	27.6652	-84.1339
472.0150	25405.7	-1.4328	270616.2	27.6237	-84.0005
474.8588	25397.9	-1.4363	268838.5	27.5621	-83.8035
476.7807	25392.0	-1.4384	267635.2	27.5202	-83.6705
479.6244	25382.4	-1.4424	265851.0	27.4581	-83.4739
484.4057	25363.9	-1.4474	262843.5	27.3529	-83.1441
487.2338	25351.0	-1.4501	261061.2	27.2902	-82.9494
489.1713	25341.4	-1.4526	259838.2	27.2472	-82.8162
491.1713	25331.0	-1.4554	258574.2	27.2026	-82.6789
494.2494	25313.6	-1.4587	256625.5	27.1337	-82.4680
496.3275	25301.1	-1.4603	255308.2	27.0869	-82.3258
498.4213	25288.0	-1.4614	253980.7	27.0397	-82.1827
501.4994	25266.7	-1.4644	252027.5	26.9700	-81.9727
503.5775	25251.2	-1.4662	250707.5	26.9228	-81.8312
505.6557	25234.7	-1.4675	249387.0	26.8754	-81.6899
508.7338	25208.2	-1.4695	247430.7	26.8050	-81.4811
510.8275	25188.4	-1.4712	246099.2	26.7570	-81.3393
512.9057	25167.2	-1.4737	244777.2	26.7091	-81.1988
515.9838	25132.5	-1.4750	242818.2	26.6380	-80.9912
518.0775	25106.7	-1.4761	241486.2	26.5895	-80.8503
520.1557	25079.7	-1.4778	240164.7	26.5413	-80.7107
523.2182	25036.3	-1.4790	238217.7	26.4699	-80.5056
525.3119	25004.3	-1.4789	236888.0	26.4210	-80.3657
527.3900	24971.1	-1.4795	235570.0	26.3724	-80.2272
529.4682	24936.2	-1.4795	234253.2	26.3236	-80.0890

GEMINI GT-3 FREE-FLIGHT AND RE-ENTRY RECONSTRUCTION

TIME (SEC)	VELOCITY MAGNITUDE (FT/SEC)	FLIGHT PATH ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
532.5463	24880.7	-1.4786	232307.0	26.2512	-79.8849
534.6244	24840.8	-1.4795	230995.7	26.2022	-79.7475
536.7025	24799.0	-1.4785	229686.5	26.1531	-79.6105
539.7963	24733.2	-1.4778	227742.7	26.0799	-79.4073
541.8744	24685.4	-1.4774	226440.2	26.0307	-79.2712
543.9525	24635.3	-1.4790	225140.5	25.9813	-79.1356
547.0463	24552.4	-1.4799	223209.0	25.9077	-78.9344
549.1244	24493.0	-1.4801	221914.5	25.8582	-78.7999
551.2025	24430.2	-1.4788	220624.2	25.8087	-78.6658
554.2963	24330.5	-1.4804	218709.7	25.7349	-78.4672
556.3900	24259.8	-1.4802	217418.0	25.6849	-78.3334
558.4682	24184.9	-1.4830	216138.5	25.6353	-78.2011
561.5463	24069.7	-1.4829	214250.0	25.5617	-78.0063
563.6400	23984.9	-1.4830	212970.5	25.5117	-77.8745
565.7182	23895.4	-1.4883	211703.5	25.4620	-77.7443
568.7963	23754.6	-1.4942	209829.2	25.3885	-77.5527
570.8900	23655.1	-1.4951	208557.7	25.3385	-77.4233
572.9838	23550.7	-1.5001	207289.7	25.2885	-77.2945
575.0619	23443.3	-1.4950	206037.2	25.2390	-77.1675
578.1400	23276.2	-1.5016	204192.2	25.1658	-76.9807
580.2182	23157.1	-1.5078	202949.7	25.1165	-76.8555
582.2963	23034.2	-1.5081	201711.2	25.0672	-76.7312
585.3744	22844.8	-1.5180	199883.7	24.9944	-76.5486
587.4682	22710.3	-1.5352	198639.0	24.9450	-76.4255
589.5463	22573.2	-1.5443	197401.0	24.8962	-76.3042
592.6244	22357.6	-1.5750	195560.2	24.8240	-76.1262
594.7025	22203.9	-1.5932	194309.2	24.7754	-76.0073
596.7807	22045.1	-1.6161	193052.0	24.7271	-75.8894

TIME (SEC)	VELOCITY MAGNITUDE (FT/SEC)	FLIGHT PATH ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
599.8588	21798.6	-1.6403	191181.5	24.6557	-75.7167
601.9525	21624.5	-1.6483	189909.7	24.6075	-75.6006
604.0150	21446.1	-1.6520	188663.7	24.5602	-75.4873
607.1088	21171.9	-1.6593	186809.5	24.4897	-75.3195
609.1869	20979.4	-1.6635	185573.7	24.4427	-75.2083
611.2650	20783.7	-1.6689	184346.7	24.3961	-75.0982
614.3432	20486.4	-1.6803	182543.7	24.3275	-74.9374
616.4213	20279.5	-1.6853	181336.0	24.2817	-74.8304
618.4994	20067.2	-1.6942	180137.0	24.2362	-74.7247
621.5775	19746.8	-1.7063	178376.0	24.1696	-74.5704
623.6557	19526.1	-1.7159	177196.7	24.1251	-74.4679
625.7338	19302.7	-1.7314	176023.2	24.0811	-74.3667
628.7963	18966.5	-1.7536	174303.2	24.0171	-74.2200
630.8744	18735.2	-1.7636	173144.2	23.9742	-74.1221
632.9525	18499.8	-1.7892	171989.0	23.9319	-74.0256
636.0150	18146.2	-1.8088	170296.0	23.8704	-73.8859
638.0932	17901.7	-1.8395	169151.7	23.8293	-73.7928
640.1713	17654.6	-1.8721	168005.0	23.7888	-73.7012
642.2494	17407.0	-1.9032	166856.7	23.7489	-73.6109
645.3275	17037.1	-1.9732	165145.7	23.6906	-73.4800
647.4057	16787.7	-2.0110	163982.5	23.6519	-73.3934
649.4838	16538.7	-2.0488	162816.0	23.6138	-73.3082
652.5619	16164.2	-2.1354	161073.7	23.5583	-73.1847
654.6244	15908.9	-2.1783	159896.0	23.5219	-73.1037
656.7025	15651.2	-2.2243	158707.0	23.4858	-73.0236
659.7807	15263.6	-2.3268	156928.5	23.4334	-72.9076
661.8588	14996.6	-2.3905	155713.7	23.3989	-72.8311
663.9213	14728.8	-2.4574	154499.2	23.3652	-72.7568

CONFIDENTIAL

CONFIDENTIAL

4160-6047-TC000

GEMINI GT-3 FREE-FLIGHT AND RE-ENTRY RECONSTRUCTION

TIME (SEC)	VELOCITY MAGNITUDE (FT/SEC)	FLIGHT PATH ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
666.9994	14327.7	-2.5698	152668.7	23.3162	-72.6486
669.0775	14057.1	-2.6580	151416.7	23.2839	-72.5774
671.1400	13787.5	-2.7516	150159.2	23.2525	-72.5082
674.2182	13384.3	-2.8909	148255.7	23.2069	-72.4078
676.2963	13110.3	-3.0050	146951.2	23.1770	-72.3420
678.3744	12835.5	-3.1341	145625.0	23.1477	-72.2776
681.4369	12429.3	-3.3295	143629.7	23.1056	-72.1857
683.5150	12155.1	-3.4640	142250.2	23.0780	-72.1252
685.5932	11881.0	-3.6049	140851.7	23.0510	-72.0662
688.6557	11475.5	-3.8284	138755.7	23.0125	-71.9821
690.7494	11198.9	-3.9904	137299.0	22.9870	-71.9265
692.8119	10921.4	-4.1530	135846.0	22.9626	-71.8732
695.8900	10507.1	-4.4253	133646.5	22.9275	-71.7966
697.9682	10221.4	-4.6257	132138.2	22.9046	-71.7469
700.0463	9938.1	-4.8441	130610.7	22.8824	-71.6987
703.1244	9519.8	-5.1811	128313.7	22.8508	-71.6303
705.2025	9235.6	-5.4315	126741.0	22.8303	-71.5861
707.2807	8951.1	-5.6947	125151.2	22.8106	-71.5434
710.3432	8534.3	-6.1158	122779.7	22.7828	-71.4834
712.4213	8253.3	-6.4295	121151.0	22.7649	-71.4446
714.4838	7971.7	-6.7507	119521.0	22.7479	-71.4077
717.5619	7565.1	-7.2877	117065.7	22.7239	-71.3553
719.6400	7293.3	-7.6759	115391.5	22.7086	-71.3218
721.7182	7028.3	-8.1099	113704.5	22.6940	-71.2898
724.7963	6643.8	-8.8425	111175.0	22.6738	-71.2450
726.8744	6389.0	-9.4159	109443.2	22.6611	-71.2165
728.9525	6136.4	-10.0759	107686.7	22.6492	-71.1893
732.0307	5774.6	-11.2054	105029.0	22.6327	-71.1517

[redacted]

[redacted]

TIME (SEC)	VELOCITY MAGNITUDE (FT/SEC)	FLIGHT PATH ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
734.1088	5541.2	-12.0960	103191.5	22.6225	-71.1280
736.1869	5316.5	-13.0802	101312.7	22.6129	-71.1055
738.2650	5098.4	-14.0294	99400.7	22.6038	-71.0843
741.3432	4782.5	-15.2377	96559.2	22.5915	-71.0551
743.4057	4575.0	-16.0565	94670.2	22.5839	-71.0370
745.4994	4373.9	-16.9691	92770.2	22.5767	-71.0198
748.5775	4087.2	-18.5018	90006.7	22.5668	-70.9967
750.6557	3905.9	-19.5675	88163.2	22.5607	-70.9824
752.7338	3738.4	-20.7238	86340.0	22.5550	-70.9691
755.8119	3506.1	-22.4918	83679.2	22.5473	-70.9511
757.8900	3360.0	-23.8659	81909.7	22.5426	-70.9400
759.9682	3224.8	-25.2454	80160.2	22.5383	-70.9297
763.0463	3035.9	-27.6119	77604.2	22.5325	-70.9159
765.1244	2917.3	-29.3385	75901.0	22.5290	-70.9074
767.1713	2807.7	-31.1282	74241.7	22.5258	-70.8997
770.2182	2658.8	-34.0617	71803.0	22.5217	-70.8894
772.2807	2569.5	-36.1849	70168.5	22.5192	-70.8831
774.3432	2489.1	-38.1551	68548.7	22.5170	-70.8772
777.3744	2373.3	-41.6865	66192.5	22.5140	-70.8695
779.4369	2304.8	-43.7853	64607.2	22.5123	-70.8648
781.4994	2233.3	-46.3926	63036.5	22.5107	-70.8605
784.5307	2141.1	-50.5371	60739.5	22.5086	-70.8550
786.5932	2077.5	-53.0684	59191.5	22.5072	-70.8517
788.6557	2025.0	-55.6715	57660.2	22.5060	-70.8487
791.7025	1957.0	-59.4415	55411.7	22.5043	-70.8449
793.7650	1915.3	-61.6316	53902.2	22.5033	-70.8426
796.7963	1859.9	-64.2692	51722.2	22.5018	-70.8397
798.8588	1827.6	-65.8823	50270.2	22.5009	-70.8380

CONFIDENTIAL
CONFIDENTIAL

6.0 TRACKING SYSTEM PERFORMANCE

6.1 Introduction

Many sets of tracking data were used in the Velocity Comparison Program during the course of the GT-3 analysis. These sets of data are obtained from essentially two different tracking systems for the ascent phase - the GE Mod III system which is used as the primary ascent guidance system and the MISTRAM (Valkyria and Eleuthera) tracking system. During the re-entry phase, tracking data was received from four radar tracking stations.

The purpose of this section is to discuss the relative merits of the different sets of data and to present velocity comparison plots using this data which have not been included in previous sections of this report.

The tracking data received on this flight included:

For Ascent

GE Burroughs
GE Final
MISTRAM I Quick Look 10K and 100K
MISTRAM II Passive
MISTRAM Final
BET

For Re-Entry

Patrick AFB TPQ-18 Radar (0:18)
Merritt Island TPQ-18 Radar (19:18)
Grand Turk TPQ-18 Radar (7:18)
Grand Bahama Island TPQ-18 Radar (3:18)

Delivery dates on most of the data were timely and considerably better than GT-2. For the ascent phase the GE Burroughs data was available on time to complete the quick look analysis. Quick Look MISTRAM data and GE Final data were received about 4 calendar days after the flight and were used to perform the final ascent guidance analysis.

For convenience all of the velocity comparisons using the different sets of data are displayed with those using quick look 100K MISTRAM data as a reference. It is felt that the 100K Quick Look MISTRAM data represented the best tracking data received on GT-3 based principally on its low noise content.

6.2 GE Mod III

The GE Mod III radio guidance system is used as primary guidance on GEMINI. The tracking portion of this system consists of a monopulse radar tracker which measures position and an interferometer rate system which measures range rate and two lateral rates. The data from this system is available from two data extraction systems - the Burroughs, where the data is sampled at a 2 per second rate, and the GE FDR (Flight Data Recording) unit, where the data is sampled at a 10 per second rate.

GE Mod III/Burroughs

The Burroughs data at a 2 per second rate is recorded on the intermediate punched paper tape. This data which consists of raw counts is available

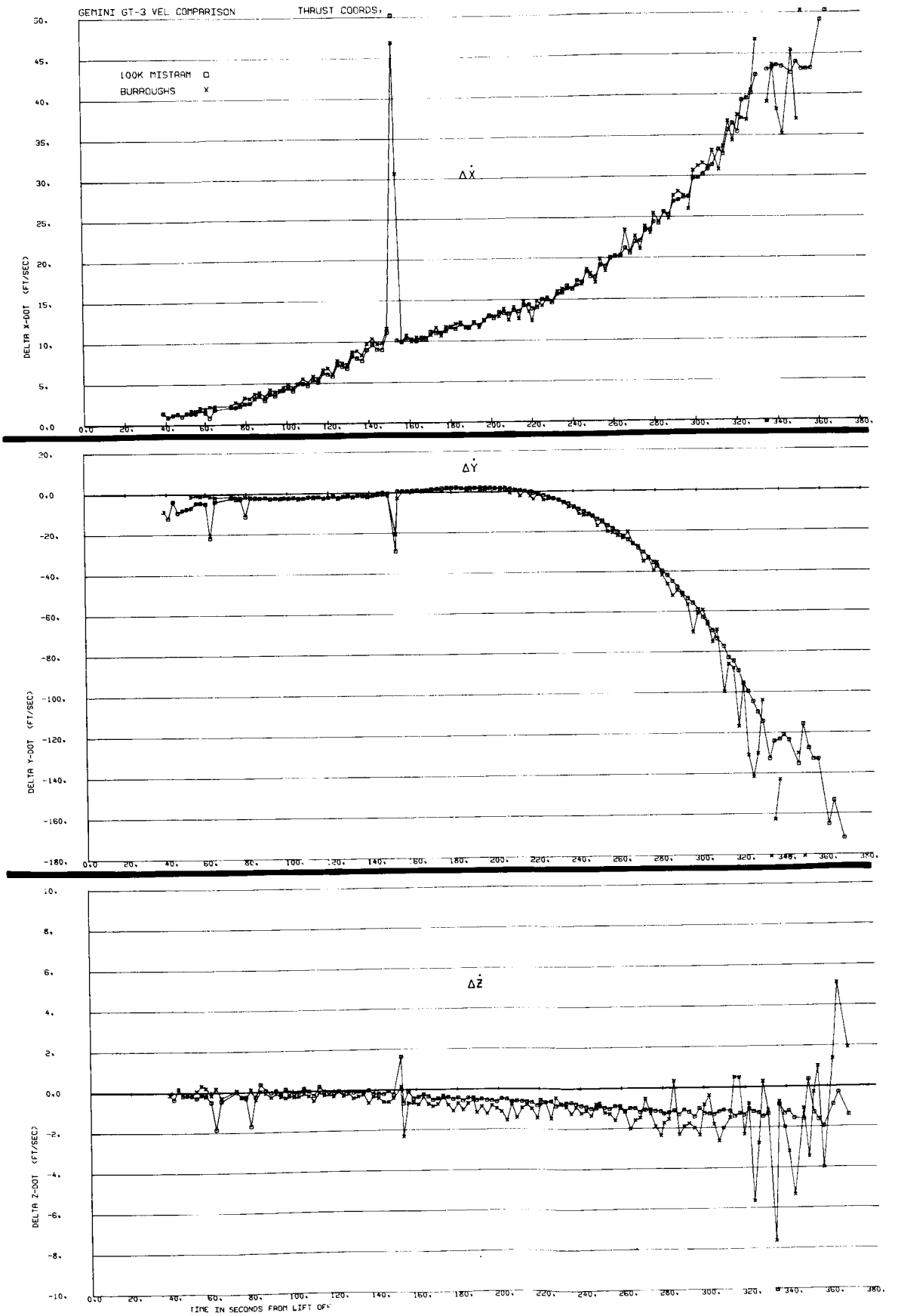
within a few hours after the flight and is processed in the STL data reduction programs and used for the quick look analysis. Figure 14 shows the velocity comparisons using Burroughs (and 100K MISTRAM) data. There is generally good agreement between the two sets of tracking data except toward the end of flight where the Burroughs data is noisy. This is expected since the elevation angle during the noisy region from 320 seconds to end of powered flight ranges from 10 degrees to less than 4 degrees and the range varies from 2.5 million feet at 320 seconds to over 3.5 million feet at 370 seconds. The timing error noted on this flight was 5 milliseconds compared to a value of 25 milliseconds noted on GT-2; an accuracy of 1 millisecond is expected.

GE Mod III/Final

GE/Final data is processed by GE/ Syracuse from the 10 per second FDR output. The velocity comparisons using this data are shown in Figure 1 of Section 3.0 of this report. The principal difference between this data and the STL processed Burroughs data in addition to the sampling rate is the smoothing and refraction corrections applied. The GE/Final Syracuse processed data has significantly more smoothing applied as can be observed by comparing it with the Burroughs data of Figure 14 late in flight. The differences in refraction correction methods did not appear to have any significant effect on this flight as there are no significant systematic differences between the Burroughs and the GE Final data.

However, there are some significant systematic differences noted between the GE final data and the 100K MISTRAM. These differences have propagated to the following values toward the end of flight; 2-3 feet per second in $\dot{X}$, 10-20 feet per second in $\dot{Y}$, and 1 foot per second in $\dot{Z}$. These differences also seem to exist between the Burroughs and 100K MISTRAM data although it is less obvious due to the higher Burroughs noise content.

Figure 14


GEMINI GT-3 VEL COMPARISON
THRUST COORDS.
100K MISTRAM □
BURROUGHS x
ΔẊ
DELTA X-DOT (FT/SEC)
ΔẎ
DELTA Y-DOT (FT/SEC)
ΔŻ
DELTA Z-DOT (FT/SEC)
TIME IN SECONDS FROM LIFT OFF

These errors are quite large especially in the Y (vertical) direction. The ratio and sense of the X to Y velocity error suggests an error in the measurement of elevation rate ($\dot{E}$) by one or both systems as opposed to an elevation type error. This suggests an error in the GE $\dot{P}$ measurement and/or the MISTRAM P measurement. The error in either case is very much larger than expected even for the low elevation angles encountered.

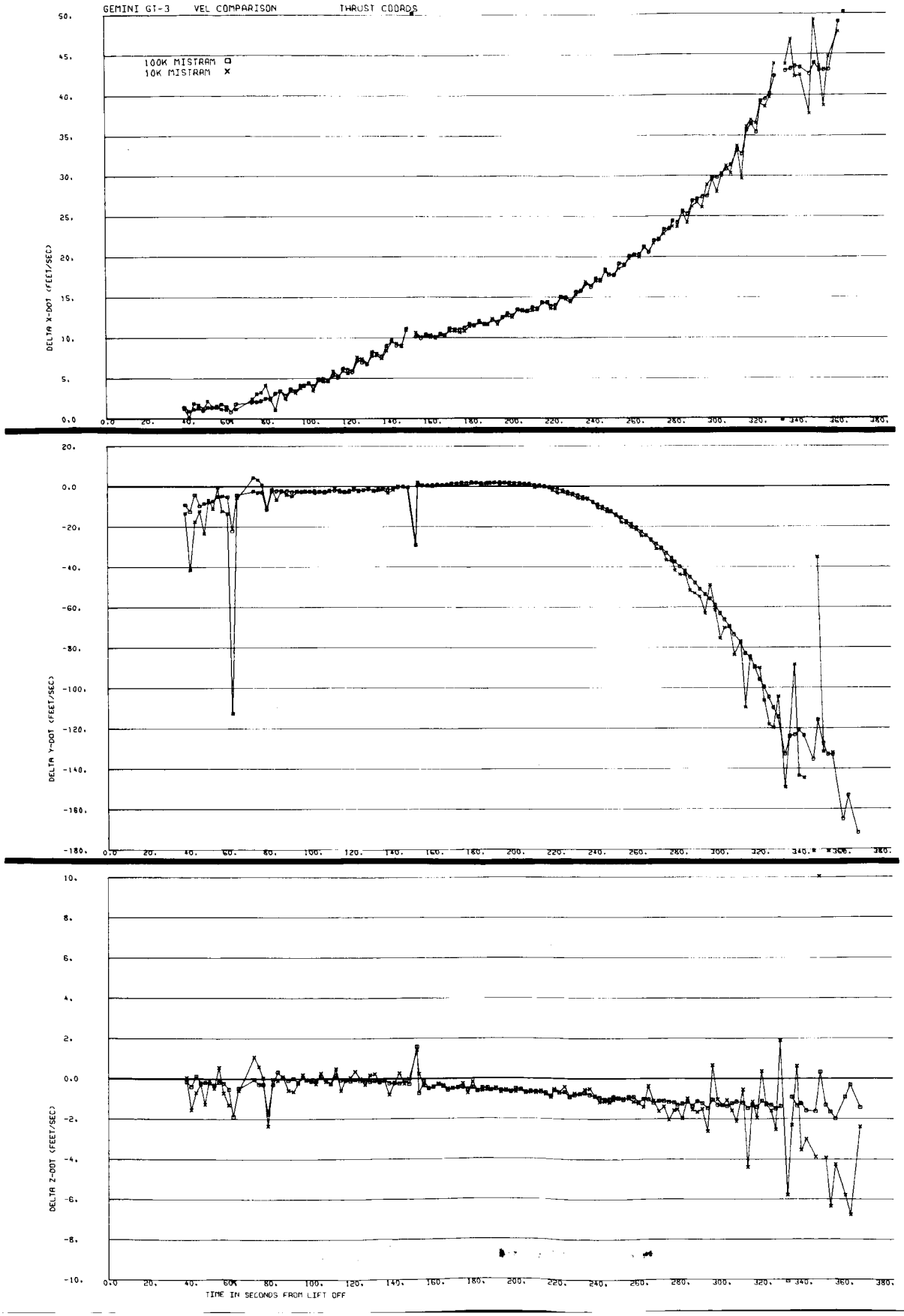
6.3 MISTRAM Data

MISTRAM Quick Look Data

The quick look MISTRAM I data received is fully scaled and corrected but unsmoothed and in the system's measurement coordinates. This consists of R. P_{10K}, Q_{10K}, P_{100K}, Q_{100K} position data where R is a range sum measurement, P_{10K}, and Q_{10K} are range difference measurements from the 10,000 foot baselines and P_{100K} and Q_{100K} are range difference measurements from the 100,000 foot baselines. The two sets of range difference measurements along with the range sum measurement were processed to give essentially two redundant sets of tracking data. This data is differentiated and rotated into the proper coordinate system by the STL programs. Figure 15 shows the multiple plot of 10K MISTRAM and 100K MISTRAM used in velocity comparisons. There is good agreement between these two sets of data except for noise content. The MISTRAM 100K data is far superior to the 10K data as far as noise content is concerned as expected. Most of the noise indicated by the velocity comparisons until late in flight is caused by the large PCM timing quantizing error.

There does not appear to be any significant ambiguities in the quick look data as were observed on GT-2. The general quality of this data is excellent.

Figure 15


GEMINI GT-3 VEL COMPARISON THRUST CODADS
100K MISTRAM □
10K MISTRAM ×
DELTA X-DOT (FEET/SEC)
DELTA Y-DOT (FEET/SEC)
DELTA Z-DOT (FEET/SEC)
TIME IN SECONDS FROM LIFT OFF

Final MISTRAM And Passive MISTRAM

The Range (ETR) generates final MISTRAM data which consists of a merge of MISTRAM 10K, 100K and passive MISTRAM II. Comparisons using final MISTRAM data are shown plotted along with 100K MISTRAM I in Figure 16.

Comparisons using MISTRAM II passive data are shown in Figure 17. There appears to be a bias in this data of about 10 feet per second toward the end of flight in $\dot{Y}$. This difference is also seen in the final MISTRAM comparisons and is presumably caused by the use of the passive MISTRAM II data in the final solution. An example of the passive MISTRAM influence on the final MISTRAM solution can be seen just before 300 seconds in Figures 16 and 17 where a systematic perturbation of like magnitude and duration is noted in both sets of data.

On this flight MISTRAM I actively tracked throughout the entire powered portion of flight. MISTRAM II passively tracked from about 190 seconds until the end of powered flight. The range sum measurements from this passive mode of tracking is ambiguous and must be zero set by the ETR in the data processing.

In summary the final MISTRAM data was disappointing and in fact degraded in comparison with the quick look data. The differences between the final and quick look MISTRAM data are extremely large from the standpoints of MISTRAM specifications although they appear small with relation to the guidance error.

BET

The BET (Best Estimate Trajectory) data is a merge of range tracking systems to produce the ETR best estimate tracking data for the flight. Comparisons using this data are shown in Figure 18. Since only the accurate ETR systems used on GEMINI are the MISTRAM systems the BET data should and does

Figure 16

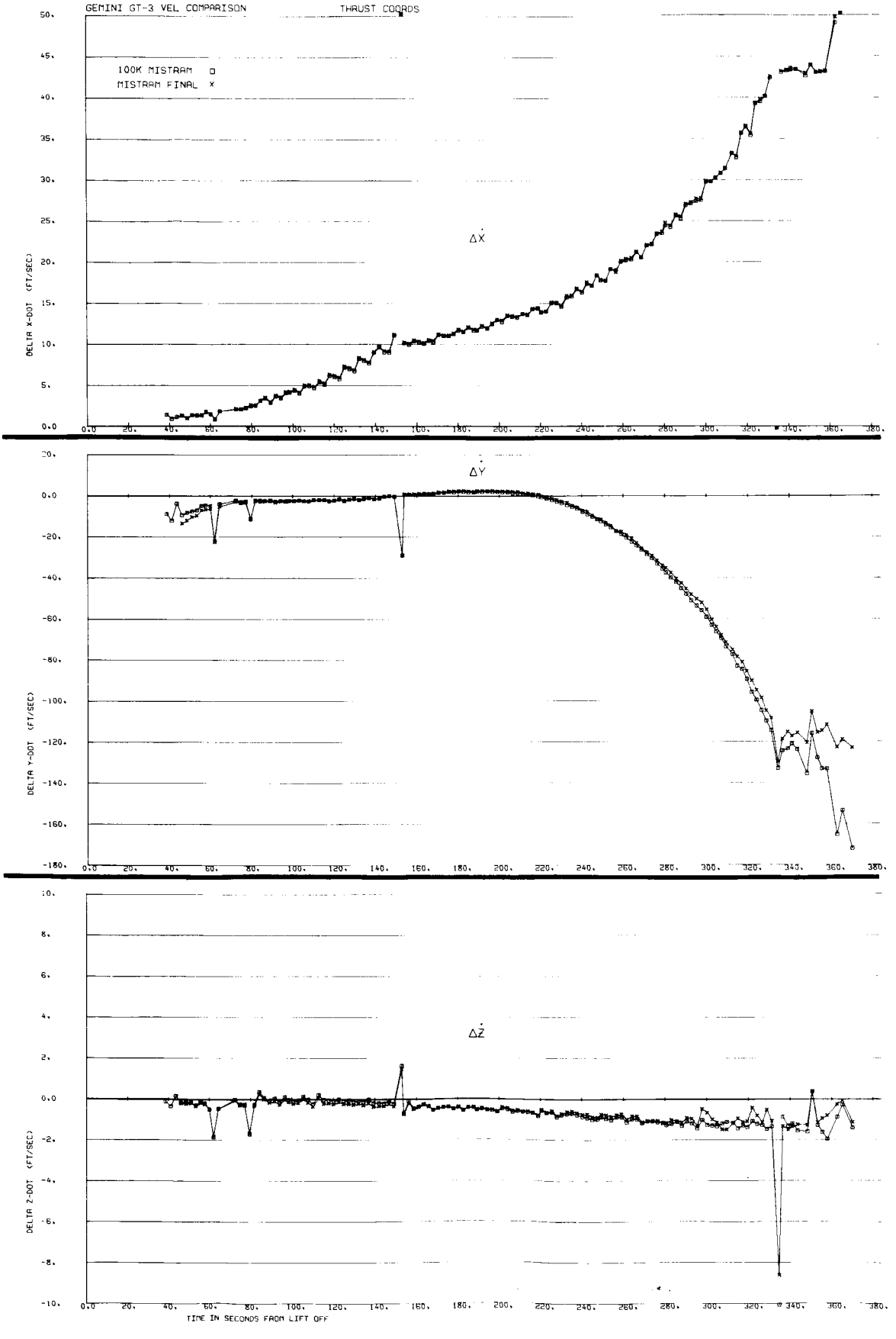

GEMINI GT-3 VEL COMPARISON
THRUST COORDS
100K MISTRAM □
MISTRAM FINAL x
ΔẊ
DELTA X-DOT (FT/SEC)
ΔẎ
DELTA Y-DOT (FT/SEC)
ΔŻ
DELTA Z-DOT (FT/SEC)
TIME IN SECONDS FROM LIFT OFF

Figure 17

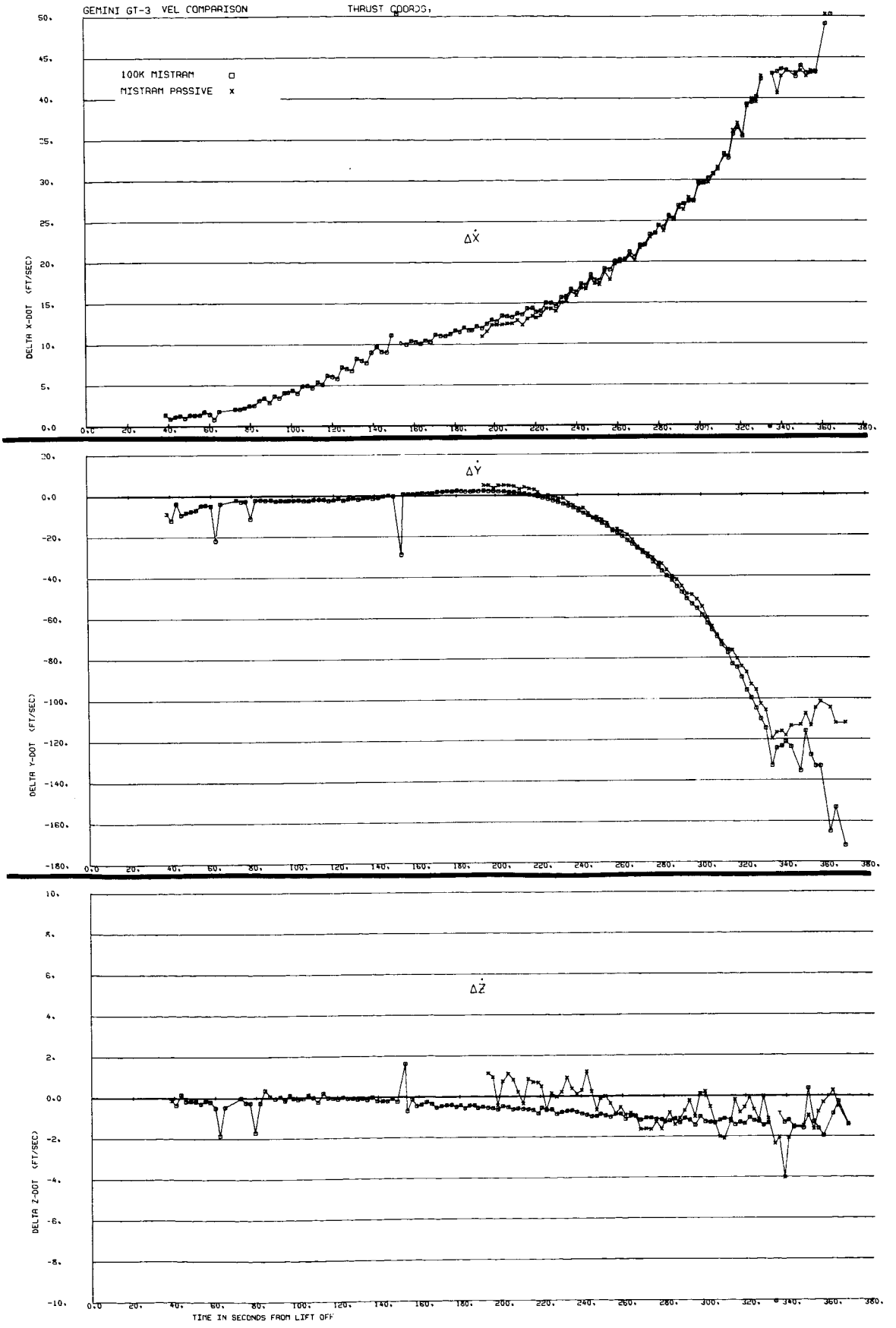
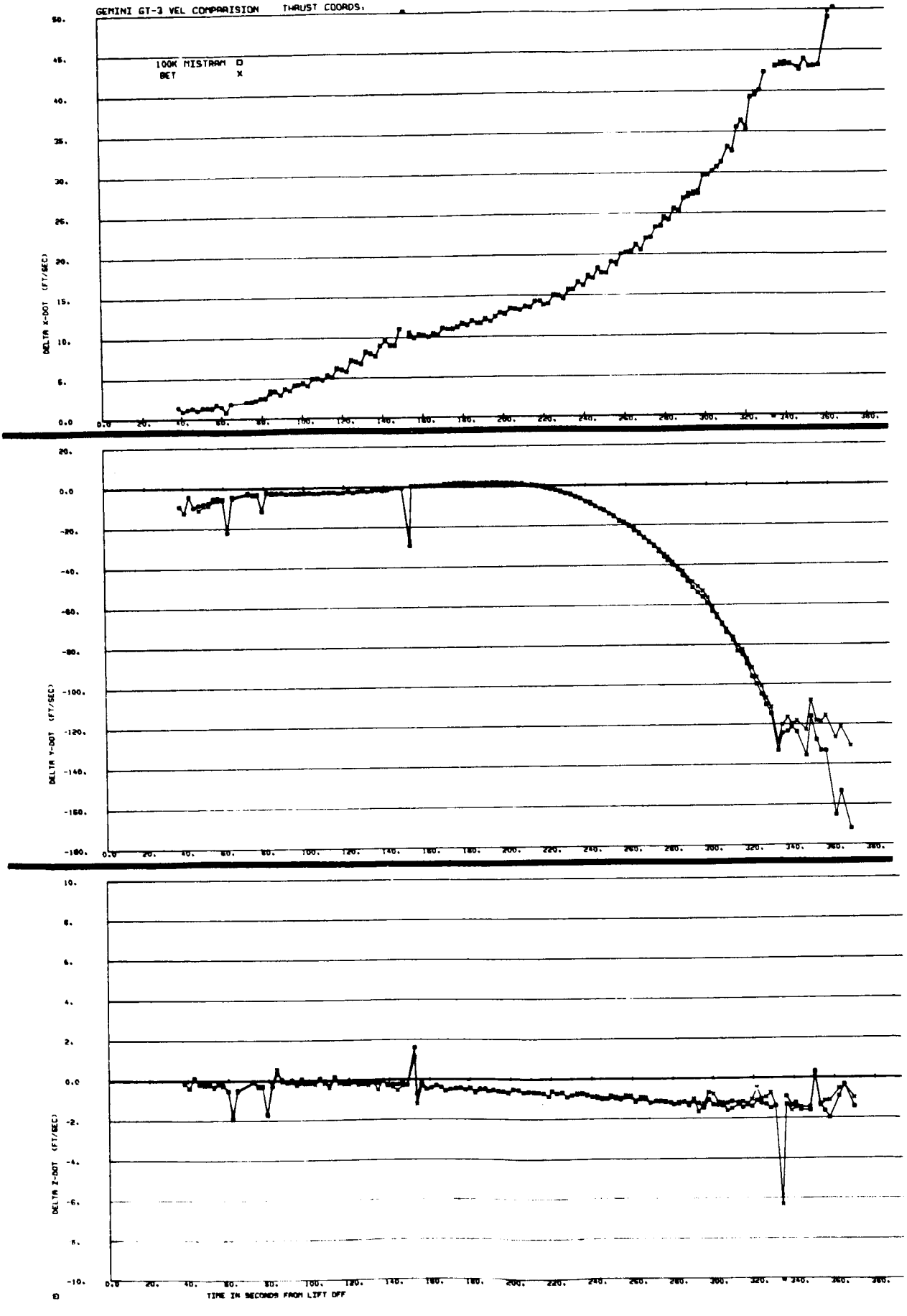

GEMINI GT-3 VEL COMPARISON
THRUST COORDS,
100K MISTRAM □
MISTRAM PASSIVE x
ΔẊ
DELTA X-DOT (FT/SEC)
ΔẎ
DELTA Y-DOT (FT/SEC)
ΔŻ
DELTA Z-DOT (FT/SEC)
TIME IN SECONDS FROM LIFT OFF

Figure 18


GEMINI GT-3 VEL COMPARISION THRUST COORDS.
100K MISTRAM D
BET X
DELTA X-DOT (FT/SEC)
DELTA Y-DOT (FT/SEC)
DELTA Z-DOT (FT/SEC)
TIME IN SECONDS FROM LIFT OFF

agree with the final MISTRAM solution. GE Mod III is not operated by the ETR and is generally not available for this purpose.

The BET like the final MISTRAM was of limited use on this flight because of the weight placed on the passive MISTRAM data.

6.4 Radar Data

Radar data from four stations were used for the re-entry analysis. MISTRAM and GE tracking are not available during this period because the beacon transponders for these systems are located in the Titan GLV. The GEMINI spacecraft does carry a radar beacon and track was accomplished with the following radars for the following time spans. Times are referenced to retro fire which occurred 16403 seconds after liftoff.

Radar	Time Span	Track Mode
Patrick (0:18)	450 - 609	Beacon
Merritt Island (19:18)	469 - 513	Beacon
	513 - 617	Skin
Grand Turk (7:18)	614 - 674	Skin
	675 - 899	Beacon
Grand Bahama Island (3:18)	595 - 686	Beacon

Position and velocity comparisons using this data are shown in Section 4.0.

The data from the GBI (3:18) radar is poor as can be espcially noted from the position comparison plots. The ETR had no explanation for this performance except that the tracking geometry from that station was very

poor. Elevation angles ranged from about 8 degrees at 595 seconds to less than 2 degrees at 686 seconds.

There is a marked discontinuity in the position comparisons around 675 seconds. At this time the velocity residuals settle down and the noise level is relatively low until end of tracking. The time of this discontinuity corresponds with the time that the Grand Turk station switched from skin to beacon mode track. The data is expected to be better in the beacon track mode. Therefore, the data from about 600 seconds to 675 seconds has to be discounted because of the combination of poor quality GBI tracking and Grand Turk skin tracking during that region.

In the Z (crossrange) direction there is about a 1,000 foot bias between the beacon track 7.18 data (after 675 seconds) and the earlier data described by the 0.18 and 19.18 radars. This error is quite large and is suspected to be in the 7.18 radar data.

6.5 Summary

In general the quality of the tracking data was excellent. It was especially gratifying to note the improved quality of MISTRAM quick look data compared to GT-2.

The principal discrepancy in the data received on this flight is the large systematic error noted between MISTRAM and GE data late in flight.

Radar data received was, in general, adequate with the exception of 3.18 data which exhibited very large systematic errors.

7.0 REFERENCES

1. 4160-6009-TU000, "Preliminary GEMINI G And C Data Reduction And Analysis Plan," by F. B. Lavenhar, dated 30 October 1964. (U)

2. 4160-6016-TU000, "GEMINI Inertial Measuring Unit Accuracy Prediction Study," by R. E. Sansom, dated 8 February 1965. (U)

3. 4160-6029-TC000, "GEMINI GT-2 Inertial Guidance System Evaluation Trajectory Reconstruction (U)," by R. J. Boyles, dated 10 March 1965. (C)

Appendix I

ASCENT THRUST PROFILE

Guidance thrust, position, velocity, and acceleration quantities during ascent are listed along with plots of the thrust accelerations and the inertial flight path angle.

Figure 19

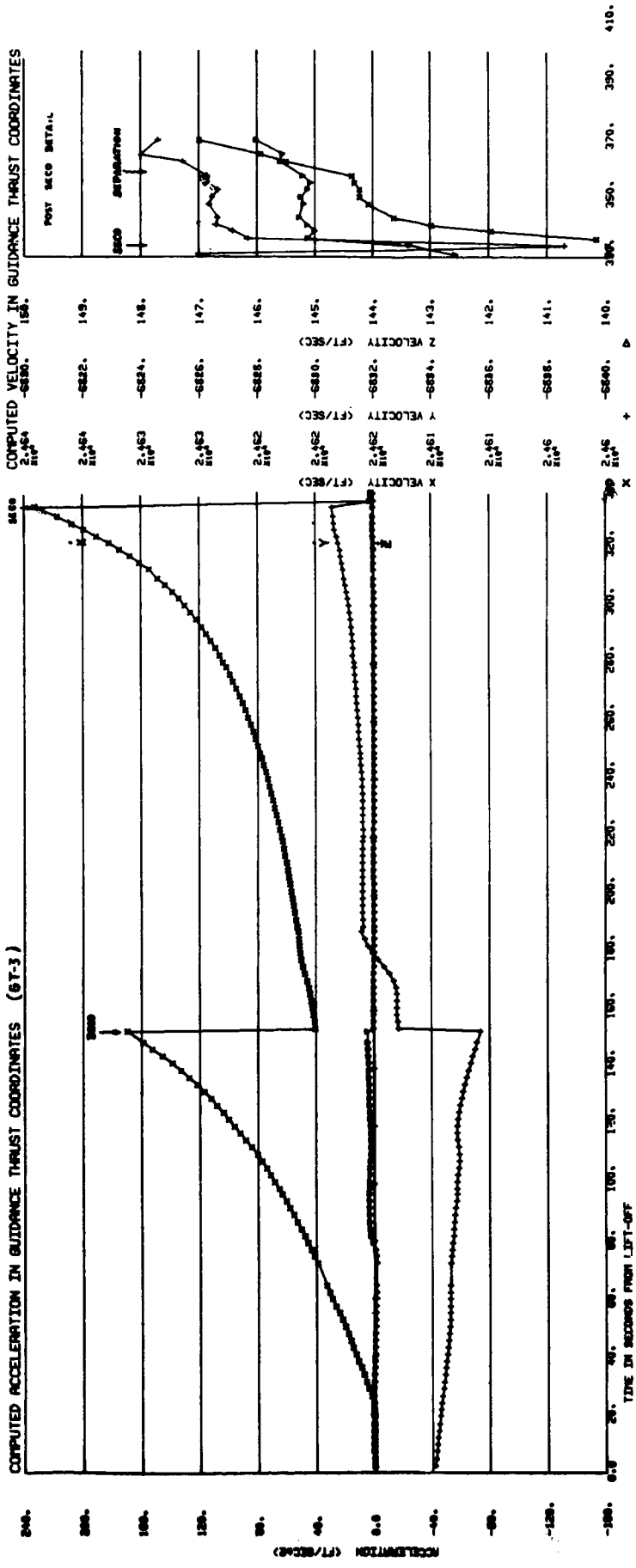
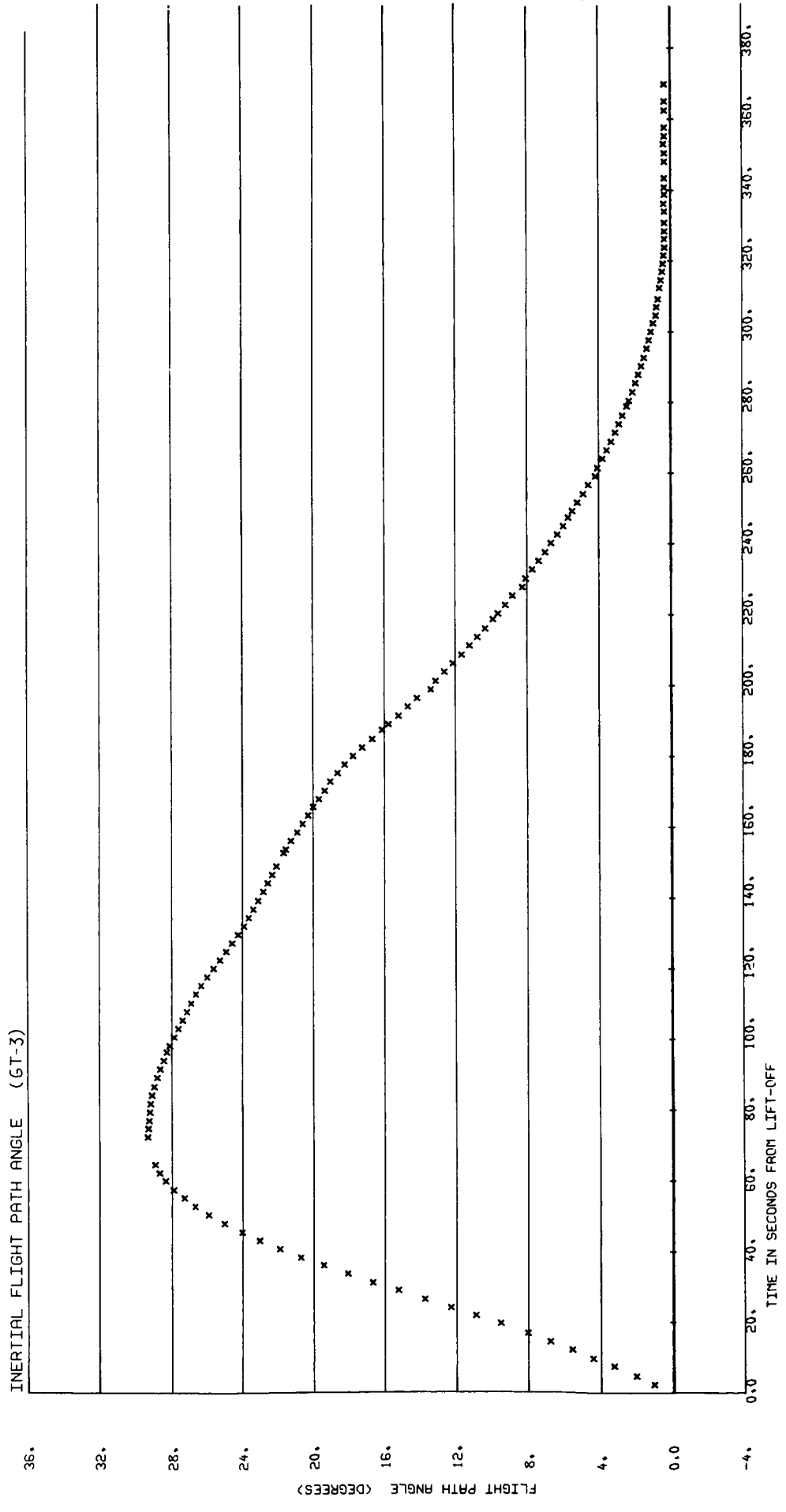

COMPUTED ACCELERATION IN GUIDANCE THRUST COORDINATES (GT-3)
COMPUTED VELOCITY IN GUIDANCE THRUST COORDINATES
POST SECO DETAIL
SECO
SEPARATION
X VELOCITY (FT/SEC)
Y VELOCITY (FT/SEC)
Z VELOCITY (FT/SEC)
ACCELERATION (FT/SEC**2)
TIME IN SECONDS FROM LIFT-OFF
X
Y
Z

Figure 20


INERTIAL FLIGHT PATH ANGLE (GT-3)
FLIGHT PATH ANGLE (DEGREES)
36.
32.
28.
24.
20.
16.
12.
8.
4.
0.0
-4.
0.0
20.
40.
60.
80.
100.
120.
140.
160.
180.
200.
220.
240.
260.
280.
300.
320.
340.
360.
380.
TIME IN SECONDS FROM LIFT-OFF

ACCELEROMETER BIASES (PULSES/SEC)

BU= .26165800 BV=-.23000200 BW=-.22332800

MISALIGNMENT AND SCALE FACTOR MATRIX

.10009750	.00015980	.00005860
.00005920	.00003415	.09749790
.00004420	-.09029480	.00013660

STAGING TIMES

LIFTOFF= .000 BOOSTER ENGINE CUTOFF= 156.250 SUSTAINER ENGINE CUTOFF= 337.450

SUM OF ACCUMULATOR COUNT DATA AT TIME ZERO

SFXO= 119.000 SFYO= -449.000 SFZ-548604.000

INTENDED AZIMUTH IN DEG.= 17.140 NUMBER OF TAPES INPUT= 1

TIME BIAS 3.452 TME 999999.000 TME 999999.000

*-TIME ADJUSTED
**-POSITION ADJUSTED
***-POS.,VEL. ADJUSTED

GEMINI EDIT PROGRAM

TIME IN SECONDS FROM LIFTOFF

COMPUTED POSITION VELOCITY AND ACCELERATION IN GUIDANCE THRUST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
2.484	-	-596		.03	-214.92	.18	-.11	-42.11	.09
4.781	-1	-1201	1	-.47	-312.17	.37	-.12	-42.62	.16
7.515	-2	-2214	3	-.87	-429.43	.98	-.15	-43.22	.23
9.812	-5	-3315	6	-.98	-529.41	1.61	-.14	-43.72	.28
12.124	-8	-4657	10	-1.58	-631.05	2.24	-.15	-44.16	.33
14.437	-11	-6235	16	-1.78	-733.87	3.04	-.17	-44.65	.38
16.765	-16	-8064	24	-2.19	-837.85	4.03	-.14	-45.18	.45
19.515	-23	-10540	37	-2.69	-963.39	5.36	-.09	-45.85	.53
21.828	-30	-12891	51	-2.80	-1070.01	6.70	.24	-46.44	.52
24.093	-38	-15435	68	-2.71	-1175.84	8.04	.93	-46.99	.47
26.499	-42	-18401	88	.29	-1289.58	8.93	2.17	-47.66	.39
28.906	-33	-21643	111	7.19	-1404.97	9.72	3.82	-48.30	.22
31.296	-3	-25141	136	18.39	-1521.62	10.52	5.49	-48.90	.03
33.703	59	-28944	160	34.00	-1639.83	9.96	7.17	-49.49	-.19
36.109	162	-33033	183	52.91	-1759.31	9.13	8.86	-50.04	-.38
38.484	314	-37354	204	75.82	-1879.17	8.11	10.60	-50.54	-.48
40.874	528	-41991	222	103.34	-2000.78	6.92	12.47	-51.03	-.61
43.265	812	-46920	236	135.47	-2122.79	5.37	14.27	-51.48	-.72
45.624	1174	-52072	246	171.49	-2245.08	3.19	16.00	-52.02	-.80
48.015	1631	-57589	252	211.52	-2369.90	1.45	17.74	-52.58	-.94
50.390	2184	-63367	254	255.65	-2495.80	-.64	19.52	-52.95	-1.18
52.749	2843	-69403	247	303.89	-2621.40	-3.91	21.49	-53.30	-1.26
55.124	3627	-75780	233	356.84	-2747.67	-8.07	23.63	-53.36	-1.25
57.499	4543	-82457	212	415.68	-2875.61	-9.80	25.93	-53.34	-1.14
59.906	5621	-89530	186	480.94	-3003.15	-12.52	28.25	-53.22	-1.11
62.281	6846	-96812	153	551.20	-3129.52	-15.24	30.28	-53.13	-1.41
64.687	8262	-104496	112	626.66	-3256.85	-18.67	32.21	-53.22	-1.71
72.343	14050	-130996	-100	895.31	-3666.15	-36.31	38.98	-53.58	-2.12
74.718	16290	-139853	-193	991.20	-3793.09	-41.00	41.22	-53.91	-1.56
77.093	18763	-149014	-297	1092.29	-3920.99	-45.60	43.38	-54.26	-.66
79.484	21500	-158543	-408	1198.18	-4051.63	-46.22	45.46	-54.88	.79
81.890	24515	-168452	-513	1309.46	-4184.22	-41.44	47.72	-55.40	2.21
84.281	27785	-178615	-601	1426.54	-4317.97	-33.49	50.16	-55.72	2.99

CONFIDENTIAL

GEMINI EOIT PROGRAM

TIME IN SECONDS FROM LIFTOFF

COMPUTED POSITION VELOCITY AND ACCELERATION IN GUIDANCE THRUST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
86.687	31365	-189166	-673	1550.33	-4452.21	-25.44	52.76	-56.06	3.27
89.109	35277	-200113	-726	1681.03	-4587.61	-18.21	55.27	-56.38	3.30
91.515	39485	-211316	-759	1817.62	-4724.27	-9.71	57.81	-56.92	3.32
93.937	44058	-222925	-772	1960.03	-4862.40	-1.49	60.39	-57.42	3.34
96.343	48953	-234793	-767	2108.64	-5001.89	6.29	63.05	-57.81	3.20
98.187	52949	-244113	-750	2226.73	-5108.33	12.28	65.27	-58.00	3.13
100.609	58536	-256656	-711	2388.15	-5249.37	19.43	68.30	-58.12	3.04
103.031	64523	-269538	-655	2556.78	-5390.01	27.03	71.29	-58.48	2.88
105.437	70888	-282677	-581	2733.32	-5530.56	33.91	74.08	-59.01	2.67
107.874	77772	-296334	-491	2916.86	-5675.38	39.89	77.08	-59.55	2.34
110.296	85063	-310257	-388	3105.31	-5821.28	45.33	80.35	-59.62	2.02
112.703	92772	-324437	-274	3303.47	-5965.32	49.69	84.27	-59.22	1.85
115.124	101024	-339056	-150	3512.15	-6107.11	53.52	88.42	-58.55	1.85
117.531	109737	-353920	-16	3730.63	-6247.34	58.16	92.38	-58.01	2.13
119.953	119047	-369218	132	3958.92	-6386.97	63.44	96.42	-58.05	2.49
122.374	128921	-384855	294	4196.72	-6526.50	70.54	100.27	-58.44	2.80
124.781	139315	-400731	472	4443.63	-6668.66	77.45	104.15	-59.19	3.00
127.203	150336	-417056	669	4699.94	-6812.76	84.99	108.28	-60.17	3.08
129.624	162091	-433733	884	4966.26	-6959.20	92.45	112.53	-61.09	3.17
132.031	174374	-450657	1116	5243.19	-7107.97	100.27	117.12	-62.13	3.24
134.453	187421	-468054	1368	5531.83	-7259.37	108.09	122.15	-63.28	3.32
136.874	201180	-485822	1639	5832.78	-7413.58	116.28	127.47	-64.46	3.43
139.281	215588	-503849	1929	6146.74	-7570.72	124.55	133.15	-65.73	3.56
141.703	230871	-522379	2241	6476.11	-7731.35	133.46	139.27	-67.05	3.74
144.124	246968	-541301	2575	6819.69	-7894.91	142.55	145.91	-68.45	3.94
146.562	264034	-560750	2935	7183.09	-8063.52	152.55	152.64	-69.93	4.14
148.968	281770	-580358	3314	7561.30	-8234.07	162.73	159.28	-71.39	4.33
152.758	311917	-612421	3970	8190.12	-8511.69	179.88	169.85	-73.72	4.64
153.812	320167	-621024	4151	8158.33	-8494.24	178.62	40.41	-16.77	.03
156.187	339655	-641242	4576	8253.26	-8531.68	178.84	40.93	-16.20	.02
158.593	359635	-661819	5006	8352.30	-8569.60	178.70	41.47	-15.63	.01
160.999	379855	-682484	5436	8453.03	-8607.03	178.74	42.41	-15.58	-.01
163.390	400188	-703105	5853	8555.37	-8643.88	178.79	43.23	-15.59	-.04

TIME IN SECONDS FROM LIFTOFF

COMPUTED POSITION VELOCITY AND ACCELERATION IN GUIDANCE THRUST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
165.765	420629	-723679	6288	8659.52	-8681.11	178.65	44.09	-15.65	-.06
168.093	440910	-743933	6703	8762.66	-8717.76	178.33	44.98	-15.24	-.08
170.499	462127	-764956	7132	8871.80	-8755.58	178.29	46.08	-13.71	-.12
172.906	483612	-786056	7561	8983.86	-8787.64	177.98	47.42	-10.94	-.18
175.312	505368	-807236	7989	9099.82	-8809.85	177.42	48.76	-7.17	-.27
177.718	527410	-828464	8415	9219.09	-8822.41	176.60	49.86	-3.00	-.35
180.124	549742	-849694	8839	9340.77	-8824.44	175.71	50.67	1.00	-.41
182.593	572957	-871464	9271	9466.37	-8815.64	174.56	51.23	4.24	-.44
185.046	595336	-893068	9698	9592.97	-8800.22	173.43	51.69	6.29	-.47
187.515	620186	-914813	10124	9720.97	-8782.45	172.29	51.96	8.93	-.41
189.187	636514	-929486	10411	9808.81	-8769.66	171.48	52.89	7.56	-.42
191.640	660737	-950977	10831	9939.61	-8750.53	170.53	53.59	7.76	-.38
194.109	685441	-972559	11250	10072.22	-8731.00	169.59	54.32	7.91	-.35
196.562	710316	-993955	11666	10206.63	-8711.48	168.82	55.05	7.95	-.30
199.015	735520	-1015303	12079	10342.84	-8691.95	168.06	55.89	7.97	-.25
201.484	761209	-1036723	12493	10481.25	-8672.23	167.66	56.65	7.96	-.23
203.937	787093	-1057976	12904	10621.76	-8652.60	167.07	57.46	7.93	-.21
206.406	813493	-1079314	13315	10764.38	-8633.26	166.49	58.34	7.87	-.20
208.874	840248	-1100605	13726	10909.20	-8613.73	166.09	59.17	7.82	-.18
211.328	867191	-1121713	14133	11055.82	-8594.78	165.69	60.16	7.83	-.16
213.796	894670	-1142909	14542	11205.04	-8575.45	165.30	61.13	7.83	-.17
216.249	922344	-1163923	14947	11356.67	-8556.10	164.90	62.00	7.86	-.15
218.718	950572	-1185023	15353	11510.89	-8536.76	164.41	62.93	7.87	-.14
220.406	970087	-1199418	15631	11617.25	-8523.67	164.42	63.80	7.80	-.14
222.874	998961	-1220440	16036	11775.88	-8504.33	163.94	64.74	7.75	-.17
225.328	1028045	-1241280	16438	11936.91	-8484.98	163.55	65.93	7.88	-.22
227.796	1057718	-1262206	16841	12100.75	-8465.44	162.79	67.08	7.91	-.25
230.265	1087799	-1283082	17242	12267.09	-8445.99	162.22	68.22	7.94	-.28
232.718	1118103	-1303778	17639	12436.73	-8426.44	161.47	69.49	8.02	-.30
235.187	1149021	-1324558	18036	12609.38	-8406.70	160.73	70.69	8.14	-.34
237.640	1180176	-1345151	18429	12784.63	-8386.37	159.80	71.91	8.33	-.35
240.109	1211961	-1365832	18823	12962.88	-8365.84	158.87	73.18	8.59	-.36
242.562	1243989	-1386331	19211	13144.74	-8344.34	158.04	74.57	8.88	-.35

CONFIDENTIAL

CONFIDENTIAL

GEMINI EDIT PROGRAM

TIME IN SECONDS FROM LIFTOFF

COMPUTED POSITION VELOCITY AND ACCELERATION IN GUIDANCE THRUST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
245.031	1276671	-1406904	19601	13329.80	-8322.05	157.12	75.85	9.20	-.33
247.484	1309603	-1427292	19985	13518.66	-8298.99	156.39	77.19	9.54	-.33
249.171	1332527	-1441286	20249	13649.04	-8282.95	155.87	78.48	9.55	-.32
251.640	1366467	-1461704	20633	13843.91	-8258.71	155.05	80.00	10.01	-.32
254.093	1400675	-1481937	21012	14042.79	-8233.69	154.14	81.59	10.37	-.30
256.562	1435591	-1502244	21392	14245.46	-8207.69	153.59	83.25	10.70	-.30
259.015	1470755	-1522355	21768	14452.15	-8180.90	152.87	84.82	10.99	-.29
261.484	1506698	-1542518	22144	14663.54	-8153.44	151.97	86.68	11.30	-.29
263.953	1543170	-1562612	22519	14879.23	-8125.28	151.43	88.44	11.59	-.30
266.406	1579880	-1582517	22890	15099.13	-8096.35	150.72	90.43	11.91	-.28
268.874	1617439	-1602468	23261	15323.83	-8066.63	149.83	92.54	12.25	-.29
271.328	1655319	-1622220	23628	15554.34	-8036.13	149.30	94.74	12.58	-.28
273.796	1694015	-1642021	23996	15790.25	-8004.65	148.59	97.05	12.90	-.26
276.249	1733052	-1661618	24359	16031.57	-7972.58	147.89	99.18	13.18	-.27
278.718	1772938	-1681260	24724	16279.30	-7939.72	147.29	101.67	13.49	-.26
280.390	1800304	-1694515	24970	16451.53	-7917.04	146.80	103.94	13.68	-.23
282.859	1841242	-1714002	25331	16709.66	-7882.82	146.29	106.55	14.67	-.24
285.312	1882565	-1733297	25690	16974.61	-7848.20	145.78	109.21	14.34	-.22
287.781	1924815	-1752633	26049	17246.76	-7812.41	145.10	112.29	14.69	-.22
290.234	1967479	-1771755	26404	17526.72	-7775.83	144.69	115.44	15.10	-.23
292.687	2010831	-1790784	26758	17813.49	-7738.47	144.11	118.80	15.53	-.22
295.124	2054619	-1809601	27109	18106.96	-7700.03	143.44	122.43	16.06	-.24
297.562	2099132	-1828321	27458	18409.04	-7660.42	143.05	126.26	16.65	-.24
299.984	2144102	-1846824	27804	18720.84	-7619.14	142.30	130.25	17.26	-.25
302.343	2188644	-1864753	28139	19032.13	-7577.77	141.73	134.40	17.94	-.24
304.656	2233027	-1882227	28466	19342.42	-7535.80	141.08	138.70	18.64	-.20
306.968	2278158	-1899600	28792	19673.23	-7491.79	140.79	144.08	19.57	-.17
309.281	2324056	-1916871	29117	20010.24	-7445.81	140.42	149.06	20.36	-.14
312.328	2385755	-1939457	29544	20473.31	-7381.94	139.96	154.96	21.30	-.13
314.640	2433531	-1956470	29868	20838.26	-7331.76	139.70	161.41	22.05	-.10
316.937	2481849	-1973250	30189	21217.72	-7279.91	139.44	167.95	22.67	-.01
319.249	2531384	-1990026	30511	21613.28	-7227.08	139.47	175.06	23.37	.07
321.578	2582210	-2006786	30837	22026.50	-7172.29	139.96	182.48	24.21	.17

GEMINI EDIT PROGRAM

TIME IN SECONDS FROM LIFTOFF

COMPUTED POSITION VELOCITY AND ACCELERATION IN GUIDANCE THRUST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
323.874	2633322	-2023192	31159	22456.61	-7115.53	140.27	190.62	25.34	.23
326.187	2685797	-2039574	31484	22905.64	-7055.75	140.97	199.59	26.66	.29
328.499	2739340	-2055814	31811	23376.00	-6992.54	141.67	201.49	27.18	.29
330.812	2793961	-2071909	32140	23871.18	-6925.99	142.57	203.39	27.70	.30
333.990	2870998	-2093840	32595	24506.25	-6838.60	143.38	206.01	28.42	.30
336.187	2924841	-2108784	32913	24600.59	-6827.69	145.13	2.89	-.05	.02
338.703	2986736	-2125959	33278	24607.86	-6827.16	145.00	2.21	.01	.02
340.828	3039031	-2140467	33586	24611.92	-6826.62	145.14	1.64	.07	.02
343.343	3100949	-2157641	33951	24614.59	-6826.67	145.28	.95	-.00	.02
347.984	3215184	-2189322	34625	24616.31	-6826.38	145.20	.17	.05	-.00
350.499	3277101	-2206498	34990	24616.98	-6826.44	145.25	.75	.21	-.01
353.015	3339031	-2223670	35356	24615.94	-6826.59	145.13	.05	.01	-.01
355.249	3394037	-2238923	35680	24617.30	-6826.35	145.08	.49	.05	.03
357.656	3453275	-2255350	36029	24617.46	-6826.30	145.22	.72	.12	.05
362.499	3572525	-2288414	36734	24622.00	-6825.43	145.60	.78	.16	.06
364.921	3632162	-2304945	37086	24623.76	-6824.02	145.56	.94	-.00	.05
365.765	3751444	-2338005	37794	24627.99	-6824.61	146.02	.54	-.07	.07

[redacted]

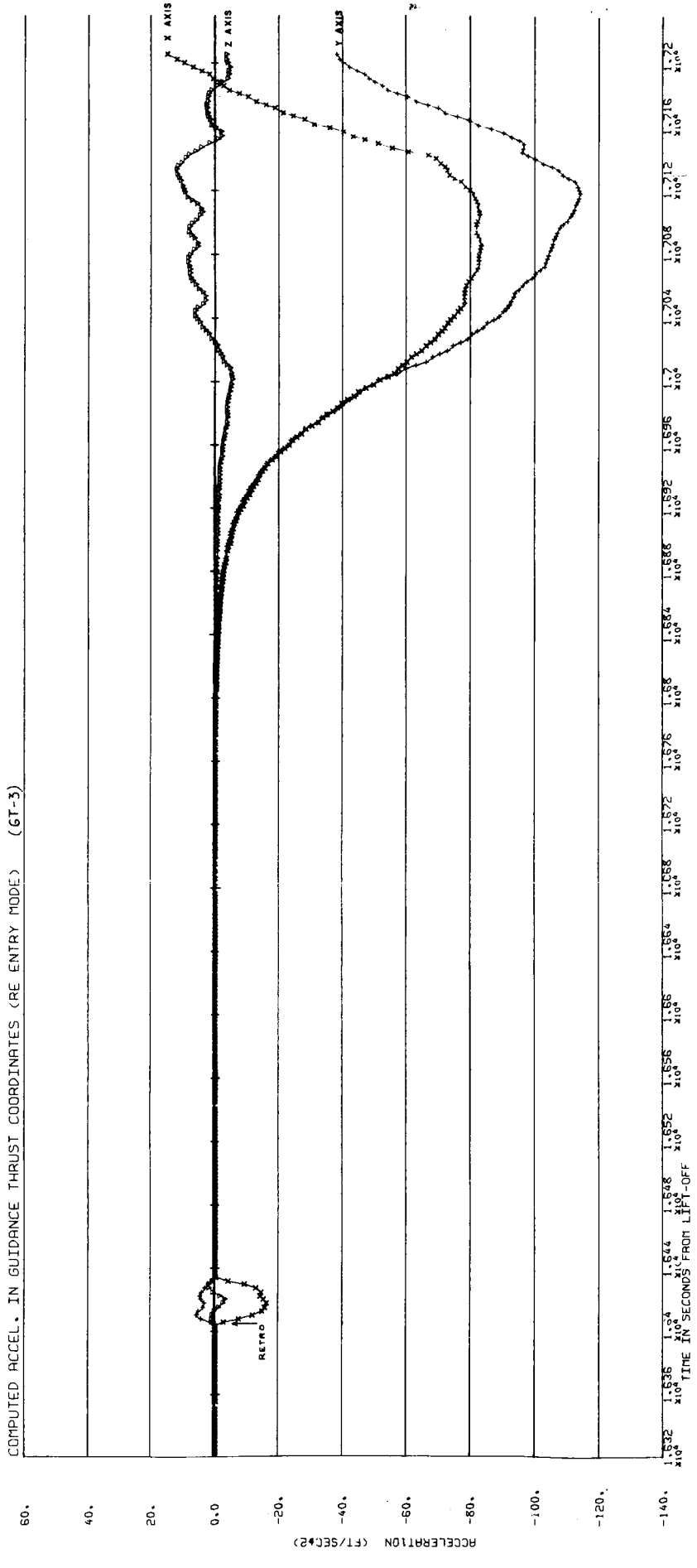
[redacted]

Appendix II

RE-ENTRY THRUST PROFILE

Guidance thrust, position, velocity, and acceleration quantities during re-entry are listed along with a plot of the thrust accelerations.

Figure 21


COMPUTED ACCEL. IN GUIDANCE THRUST COORDINATES (RE ENTRY MODE) (GT-3)
X AXIS
Z AXIS
Y AXIS
RETRO
ACCELERATION (FT/SEC**2)
60.
40.
20.
0.0
-20.
-40.
-60.
-80.
-100.
-120.
-140.
TIME IN SECONDS FROM LIFT-OFF
1.632 x10⁴
1.636 x10⁴
1.64 x10⁴
1.644 x10⁴
1.648 x10⁴
1.652 x10⁴
1.656 x10⁴
1.66 x10⁴
1.664 x10⁴
1.668 x10⁴
1.672 x10⁴
1.676 x10⁴
1.68 x10⁴
1.684 x10⁴
1.688 x10⁴
1.692 x10⁴
1.696 x10⁴
1.7 x10⁴
1.704 x10⁴
1.708 x10⁴
1.712 x10⁴
1.716 x10⁴
1.72 x10⁴

INPUT PARAMETERS

ACCELEROMETER BIASES (PULSES/SEC)

BU= .26165800 BV=-.23000200 BW=-.22332800

MISALIGNMENT AND SCALE FACTOR MATRIX

.10009750	.00015980	.00000360
.00005920	.00003415	.09749790
.00004420	-.09029480	.00013660

STAGING TIMES

LIFTOFF= .000 BOOSTER ENGINE CUT 1000000.000 SUSTAINER ENGINE CUTO 1000000.000

SUM OF ACCUMULATOR COUNT DATA AT TIME ZERO

SFX0= -103.000 SFY0= 139.000 SFZ0= 167.000

INTENDED AZIMUTH IN DEG.= 17.100 NUMBER OF TAPES INPUT= 1

TIME BIAS= .000 TME 999999.000 TME 999999.000

*-TIME ADJUSTED
**-POSITION ADJUSTED
***-POS.,VEL. ADJUSTED

GEMINI EDIT PROGRAM

[redacted] POSITION, VELOCITY AND ACCELERATION IN GUIDANCE THRUST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
1.890	-27.5	18.8	4.6	-29.88	18.17	4.02	-14.62	9.24	1.99
[redacted]	[redacted]	94.1	21.0	[redacted]	40.42	8.43	-15.18	5.76	.34
6.953	-381.6	199.7	39.7	-103.50	47.36	5.94	-15.68	3.89	-1.24
9.459	-681.5	321.9	49.2	-146.67	50.40	1.11	-16.14	3.66	-2.76
12.031	-1109.3	467.4	38.4	-188.42	62.42	-8.05	-14.89	4.59	-3.20
13.953	-1496.3	601.1	10.9	-218.07	75.33	-16.41	-14.39	4.98	-2.12
16.484	-2080.8	805.7	-37.5	-246.02	87.15	-22.67	-14.20	4.43	.16
[redacted]	[redacted]	1038.9	-78.9	[redacted]	95.65	-12.96	-12.67	3.11	1.98
21.562	-3590.1	1294.7	-100.0	-327.79	104.54	-4.06	-8.36	1.78	1.85
23.484	-4178.2	1495.3	-108.2	-331.24	105.37	-3.39	-4.76	1.01	1.00
26.031	-5021.2	1763.5	-116.8	-331.37	105.32	-3.34	-.31	.07	.06
28.562	-5859.8	2030.1	-125.4	-331.21	105.36	-3.29	.02	.01	.00
31.109	-6703.2	2298.4	-134.0	-331.14	105.30	-3.51	.02	.00	.00
[redacted]	[redacted]	[redacted]	-142.5	[redacted]	105.44	-3.27	.00	.02	.01
35.562	-8177.7	2767.6	-148.9	-331.12	105.30	-3.32	.00	.02	.01
38.109	-9021.0	3036.2	-157.3	-331.16	105.54	-3.27	.00	.01	-.02
40.656	-9864.4	3304.8	-165.8	-331.09	105.49	-3.40	.03	.01	-.01
43.187	-10702.2	3571.8	-174.4	-331.02	105.43	-3.44	-.00	-.01	-.01
45.109	-11338.4	3774.4	-181.1	-330.87	105.49	-3.40	-.00	.01	.03
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	-.02	.02	.06
[redacted]	[redacted]	4810.4	-197.7	-331.04	105.67	-3.02	-.02	-.00	.07
[redacted]	[redacted]	4579.3	-205.1	-331.17	105.61	-2.79	.02	-.02	.03
55.285	-14701.0	4846.4	-212.3	-331.11	105.36	-2.82	-.00	-.06	-.02
57.203	-15342.5	5050.5	-218.0	-330.96	105.42	-3.05	.01	-.04	-.05
59.968	-16258.1	5341.6	-226.5	-331.18	105.06	-3.09	.00	-.01	-.04
[redacted]	[redacted]	[redacted]	-234.1	-331.02	105.30	-3.22	.01	-.01	-.04
64.812	-17861.7	5651.4	-242.0	-331.06	105.35	-3.26	.03	.03	-.03
67.234	-18663.3	6106.3	-250.1	-330.89	105.20	-3.48	.01	.03	-.02
69.656	-19464.8	6361.6	-258.3	-330.93	105.44	-3.34	.02	.04	-.02
72.078	-20266.3	6617.2	-266.5	-330.97	105.68	-3.38	.01	.03	-.01
74.374	-21026.3	6859.7	-274.4	-330.81	105.53	-3.51	.01	.01	-.02
[redacted]	[redacted]	7113.7	-282.9	-330.84	105.58	-3.46	.03	.01	.02
[redacted]	[redacted]	7369.5	-291.2	-330.88	105.62	-3.50	.02	.01	.04

[redacted]

GEMINI EDIT PROGRAM

COMPUTED POSITION,VELOCITY AND ACCELERATION IN GUIDANCE THRUST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
81.524	-23424.7	7625.4	-299.2	-330.62	105.76	-3.18	.02	.02	.03
84.046	-24225.5	7881.4	-307.0	-330.65	105.61	-3.22	.02	.02	.01
86.468	-25026.4	8137.5	-314.8	-330.69	105.85	-3.26	-.00	.02	-.03
88.765	-25785.9	8380.6	-322.5	-330.63	105.80	-3.30	.00	.02	-.01
91.078	-26550.5	8625.3	-330.1	-330.67	105.85	-3.43	.01	-.00	-.02
93.578	-27377.2	8889.8	-338.6	-330.60	105.80	-3.29	.01	.01	-.01
95.999	-28177.8	9146.2	-346.9	-330.64	105.84	-3.51	.02	-.01	-.00
98.421	-28978.4	9402.5	-355.2	-330.48	105.89	-3.37	.02	.00	.01
100.343	-29778.9	9658.8	-363.4	-330.51	105.74	-3.41	.00	-.02	.02
103.265	-30579.3	9915.0	-371.5	-330.45	105.88	-3.27	-.01	-.01	.01
105.562	-31338.5	10157.9	-379.0	-330.59	105.63	-3.31	.01	.00	.00
107.171	-31870.5	10328.2	-384.3	-330.55	105.79	-3.28	.00	-.01	-.02
110.374	-32929.0	10666.9	-395.2	-330.36	105.82	-3.39	.02	.02	-.02
112.735	-33729.2	10923.1	-403.5	-330.40	105.67	-3.52	.02	.00	-.01
115.218	-34529.4	11179.2	-411.9	-330.44	105.91	-3.38	-.01	.02	.01
117.640	-35329.6	11435.5	-420.1	-330.27	105.76	-3.42	.00	.03	.02
120.062	-36129.8	11692.1	-428.2	-330.51	106.00	-3.28	.01	.02	-.00
122.468	-36924.8	11947.2	-436.2	-330.35	106.04	-3.32	.01	.01	-.01
124.874	-37719.7	12202.2	-444.3	-330.28	105.99	-3.45	.03	-.00	-.02
127.171	-38478.4	12445.6	-452.2	-330.32	105.84	-3.41	.02	-.01	.00
129.593	-39278.2	12702.2	-460.5	-330.16	106.08	-3.45	.01	.01	.01
132.015	-40078.0	12958.9	-468.7	-330.20	105.93	-3.31	.01	.02	-.00
136.059	-41677.6	13472.5	-485.0	-330.27	106.02	-3.48	.02	-.02	-.02
139.156	-42436.0	13716.0	-493.0	-330.11	106.07	-3.43	.03	-.01	-.01
141.671	-43266.3	13982.5	-501.8	-330.04	105.82	-3.56	.02	.00	.00
143.968	-44024.4	14225.9	-509.7	-329.98	105.97	-3.42	.01	.00	-.00
146.390	-44823.7	14482.6	-518.2	-330.12	106.11	-3.46	-.01	.03	.01
148.812	-45623.1	14739.4	-526.5	-329.96	105.96	-3.50	-.02	.01	.01
151.234	-46422.5	14996.3	-534.8	-330.19	106.20	-3.36	-.02	.01	.01
153.656	-47222.2	15253.4	-543.1	-330.23	106.05	-3.40	-.00	.02	.01
155.140	-47712.4	15410.9	-548.1	-330.19	106.21	-3.37	.02	.01	-.01
158.468	-48811.0	15764.4	-559.3	-330.01	106.24	-3.39	.03	.01	-.01
160.765	-49568.9	16008.4	-567.2	-329.94	106.19	-3.43	.01	-.01	.00
163.187	-50368.1	16265.8	-575.5	-329.98	105.23	-3.47	.02	-.01	.01

GEMINI EDIT PROGRAM

COMPUTED POSITION, VELOCITY AND ACCELERATION IN GUIDANCE THRUST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
165.609	-51167.3	16522.7	-583.7	-330.02	106.08	-3.33	.01	.01	.01
168.031	-51966.4	16779.9	-591.9	-329.75	106.22	-3.37	.01	.01	.01
170.453	-52765.3	17037.2	-600.1	-329.99	106.27	-3.41	.01	.01	-.01
172.843	-53554.0	17291.3	-608.2	-329.83	106.31	-3.36	-.01	-.01	.00
175.265	-54352.9	17548.6	-616.4	-329.87	106.16	-3.40	.00	-.01	.01
177.562	-55110.6	17792.5	-624.0	-329.91	106.21	-3.35	.00	.00	-.01
179.984	-55909.7	18049.9	-632.2	-329.94	106.25	-3.30	.01	.00	-.02
182.406	-56708.5	18307.2	-640.5	-329.78	106.30	-3.52	.01	.01	-.02
184.828	-57507.4	18564.6	-649.1	-329.81	106.15	-3.56	.01	-.01	-.01
187.124	-58265.0	18808.6	-657.1	-329.85	106.39	-3.51	.01	.01	.00
189.640	-59094.6	19075.9	-665.8	-329.79	106.14	-3.37	.01	.02	-.00
192.052	-59893.3	19333.4	-674.3	-329.83	106.38	-3.59	.01	.00	.00
194.374	-60655.7	19579.7	-682.8	-329.87	106.43	-3.54	.00	.01	-.00
196.781	-61449.3	19835.6	-691.1	-329.70	106.28	-3.40	.01	-.01	.01
199.203	-62248.0	20093.2	-699.4	-329.74	106.32	-3.44	.02	-.00	.00
201.624	-63046.4	20350.7	-707.8	-329.58	106.37	-3.48	.01	.01	-.01
203.109	-63535.8	20508.6	-713.0	-329.74	106.34	-3.45	.01	.01	-.00
206.437	-64633.0	20852.6	-724.5	-329.55	106.36	-3.47	.01	.00	-.01
208.859	-65431.2	21120.2	-733.0	-329.59	106.41	-3.51	.01	.00	.00
211.171	-66193.3	21366.3	-741.1	-329.53	106.36	-3.56	.00	-.00	.01
213.593	-66991.5	21624.0	-749.6	-329.56	106.40	-3.42	.00	-.00	.02
215.959	-67784.5	21879.9	-757.8	-329.50	106.35	-3.46	-.00	.02	.01
218.421	-68582.6	22137.7	-766.1	-329.54	106.39	-3.32	.01	.02	-.01
220.828	-69375.6	22393.9	-774.3	-329.57	106.63	-3.45	.02	.01	.00
223.249	-70173.5	22651.9	-782.6	-329.41	106.48	-3.49	.01	.01	-.00
225.656	-70966.3	22908.2	-790.8	-329.35	106.43	-3.35	.02	.00	.01
227.968	-71728.1	23154.5	-798.7	-329.49	106.58	-3.39	-.01	.01	-.00
230.390	-72526.0	23412.5	-806.9	-329.32	106.62	-3.43	-.01	.02	-.01
232.812	-73324.1	23670.7	-815.1	-329.56	106.47	-3.47	-.01	.01	-.01
235.109	-74080.8	23915.6	-823.0	-329.40	106.71	-3.42	-.00	.01	-.01
237.624	-74909.7	24183.3	-831.7	-329.53	106.66	-3.46	.01	.02	.01
240.046	-75707.6	24442.3	-840.1	-329.37	106.70	-3.50	.02	-.01	.01
242.468	-76505.4	24700.7	-848.4	-329.41	106.75	-3.36	.01	-.01	.00

GEMINI EDIT PROGRAM

COMPUTED POSITION, VELOCITY AND ACCELERATION IN GUIDANCE THRUST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
244.765	-77261.9	24945.8	-856.2	-329.25	106.60	-3.31	.00	-.01	.00
247.187	-78059.7	25204.1	-864.5	-329.48	106.64	-3.53	-.01	-.00	-.00
249.609	-78858.7	25462.9	-872.8	-329.32	106.69	-3.39	.05	-.02	-.01
251.093	-79347.7	25621.2	-877.9	-329.48	106.66	-3.36	.03	-.01	-.00
254.045	-80320.2	25936.0	-888.0	-329.10	106.50	-3.48	.01	-.00	-.03
255.968	-80953.0	26140.9	-894.7	-329.25	106.65	-3.53	.01	-.00	-.02
258.796	-81885.3	26442.9	-905.2	-329.28	106.68	-3.65	-.01	.01	-.00
261.624	-82815.6	26744.5	-915.3	-329.30	106.52	-3.50	-.00	.00	.01
263.546	-83449.5	26949.4	-922.3	-329.25	106.68	-3.55	-.00	-.00	.01
266.390	-84386.0	27252.7	-932.3	-329.28	106.71	-3.49	-.02	.03	-.01
268.295	-85013.3	27456.1	-939.0	-329.33	105.57	-3.54	-.01	.02	-.00
271.140	-35953.3	27761.7	-949.5	-329.46	106.90	-3.57	.01	-.01	-.00
273.062	-86586.8	27967.3	-956.4	-329.31	106.76	-3.53	.02	-.01	.01
275.890	-87520.5	28271.5	-967.5	-329.33	106.60	-3.57	.03	-.04	.01
277.812	-88153.4	28475.4	-974.3	-329.08	106.56	-3.44	-.01	-.02	.01
280.640	-89084.7	28777.9	-984.2	-329.31	106.60	-3.56	-.03	.02	.01
282.562	-89715.5	28982.6	-991.5	-329.45	105.55	-3.43	-.02	.02	-.01
285.390	-90647.1	29284.2	-1001.4	-329.48	106.79	-3.46	-.01	.02	.00
287.312	-91280.2	29489.6	-1008.3	-329.33	106.65	-3.60	-.02	.01	-.01
290.140	-92212.1	29791.4	-1018.1	-329.45	106.78	-3.45	-.04	-.01	.01
292.062	-92845.6	29996.5	-1024.8	-329.71	106.64	-3.50	-.06	-.00	.01
294.905	-93783.2	30299.8	-1034.7	-329.73	106.68	-3.44	-.03	-.03	-.01
296.812	-94411.8	30503.1	-1041.4	-329.89	105.64	-3.49	.01	-.00	-.00
299.656	-95349.5	30806.4	-1051.3	-329.71	106.48	-3.52	.02	-.02	-.01
301.562	-95978.0	31009.5	-1058.0	-329.56	106.73	-3.48	.00	.00	-.01
304.406	-96915.6	31312.6	-1068.0	-329.69	106.47	-3.52	-.02	.01	-.01
307.234	-97848.2	31614.1	-1078.0	-329.91	106.70	-3.64	-.03	-.01	-.00
309.156	-98482.1	31819.0	-1084.9	-329.76	106.56	-3.51	-.05	-.00	.00
311.984	-99415.3	32120.4	-1094.9	-329.89	106.50	-3.54	-.04	-.03	.01
313.906	-100049.7	32325.1	-1101.7	-330.34	106.56	-3.50	-.04	-.01	-.01
316.740	-100988.6	32628.0	-1111.7	-330.16	106.40	-3.53	-.03	.01	-.01
318.671	-101623.4	32832.7	-1118.5	-330.11	106.55	-3.58	-.01	-.00	.01
321.499	-102556.8	33133.3	-1128.6	-330.34	106.59	-3.61	-.04	.00	.00

April 3, 1965

GEMINI EDIT PROGRAM

COMPUTED POSITION, VELOCITY AND ACCELERATION IN GUIDANCE THRUST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
323.421	-103191.7	33338.1	-1135.4	-330.39	106.45	-3.39	-.04	-.01	-.01
326.249	-104125.5	33639.0	-1145.3	-330.41	106.48	-3.60	-.04	-.02	.00
328.171	-104761.8	33843.6	-1152.1	-330.56	106.44	-3.66	-.05	-.02	.00
331.015	-105702.2	34146.1	-1162.1	-330.79	106.28	-3.42	-.08	-.02	.02
332.921	-106332.8	34348.8	-1168.8	-330.84	106.34	-3.47	-.07	-.03	-.00
335.765	-107274.1	34651.0	-1178.8	-331.17	106.27	-3.50	-.07	-.03	-.01
337.687	-107910.6	34855.1	-1185.5	-331.22	106.14	-3.64	-.06	-.03	-.01
340.515	-108847.7	35155.2	-1195.6	-331.44	105.98	-3.49	-.06	-.03	-.00
342.437	-109484.7	35359.1	-1202.4	-331.39	106.13	-3.54	-.07	-.01	.02
345.281	-110427.8	35660.6	-1212.3	-331.82	105.97	-3.57	-.08	.00	.00
347.187	-111060.3	35862.7	-1219.0	-331.87	106.03	-3.35	-.08	-.02	.01
350.031	-112004.5	36164.1	-1228.9	-332.09	106.06	-3.56	-.07	-.02	-.00
352.959	-112944.0	36463.8	-1238.6	-332.22	105.80	-3.42	-.09	-.03	-.01
354.781	-113592.9	36667.2	-1245.3	-332.47	105.85	-3.55	-.09	-.03	.01
357.603	-114525.1	36967.7	-1255.2	-332.80	105.80	-3.41	-.12	-.06	.01
359.531	-115164.8	37170.9	-1261.9	-332.85	105.66	-3.46	-.13	-.08	.01
362.374	-116112.3	37470.9	-1271.7	-333.47	105.30	-3.40	-.13	-.08	-.02
364.296	-116751.6	37674.4	-1278.9	-333.72	105.16	-3.45	-.11	-.05	-.03
367.124	-117695.7	37971.9	-1288.9	-333.85	105.10	-3.55	-.10	-.03	-.04
369.062	-118342.9	38175.6	-1296.0	-334.10	105.16	-3.71	-.12	-.03	-.03
371.906	-119293.6	38474.3	-1306.6	-334.52	105.00	-3.74	-.12	-.06	-.02
373.828	-119935.6	38675.7	-1313.8	-334.77	104.86	-3.79	-.11	-.07	-.01
376.671	-120888.0	38973.6	-1324.6	-335.00	104.50	-3.83	-.13	-.06	-.02
378.595	-121532.3	39174.6	-1332.0	-335.25	104.56	-3.79	-.15	-.07	-.01
381.437	-122480.1	39464.2	-1344.2	-335.88	104.40	-4.00	-.22	-.05	-.02
383.359	-123125.8	39652.4	-1352.0	-336.13	104.07	-3.87	-.21	-.19	-.03
386.203	-124082.7	39947.8	-1363.4	-336.75	103.71	-4.08	-.24	-.16	-.03
388.124	-124730.5	40146.7	-1371.2	-337.30	103.28	-4.13	-.25	-.17	-.05
390.968	-125690.7	40439.3	-1383.2	-338.13	102.92	-4.17	-.25	-.18	-.06
392.890	-126340.8	40637.1	-1391.5	-338.38	102.39	-4.40	-.24	-.17	-.08
395.734	-127304.5	40929.0	-1404.4	-339.21	102.04	-4.61	-.27	-.18	-.10
397.671	-127962.3	41125.2	-1413.6	-339.66	101.70	-4.93	-.31	-.20	-.10
400.515	-128929.8	41413.4	-1427.9	-340.68	101.15	-5.14	-.34	-.23	-.10
402.437	-129585.2	41607.1	-1438.0	-341.33	100.43	-5.38	-.36	-.24	-.09

GEMINI EDIT PROGRAM

COMPUTER POSITION, VELOCITY AND ACCELERATION IN GUIDANCE TRUST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
405.281	-130557.4	41892.1	-1453.5	-342.34	99.88	-5.59	-.38	-.26	-.08
407.203	-131216.0	42083.3	-1464.4	-343.11	99.45	-5.82	-.37	-.25	-.07
410.046	-132193.3	42364.8	-1481.0	-344.34	98.51	-5.85	-.41	-.29	-.07
411.968	-132855.8	42553.7	-1492.6	-344.79	98.17	-6.09	-.47	-.32	-.09
414.812	-133839.1	42831.0	-1510.2	-346.41	97.04	-6.30	-.50	-.34	-.10
417.656	-134826.4	43105.7	-1528.8	-348.04	96.10	-6.70	-.55	-.37	-.11
419.578	-135496.2	43289.6	-1541.8	-348.89	95.37	-6.84	-.58	-.39	-.12
422.421	-136491.4	43559.0	-1561.8	-350.72	94.24	-7.23	-.64	-.44	-.11
424.343	-137166.9	43739.9	-1575.9	-351.97	93.32	-7.46	-.72	-.48	-.14
427.187	-138171.1	44002.2	-1597.7	-354.10	91.89	-7.68	-.77	-.54	-.15
429.109	-138853.4	44177.7	-1613.1	-355.75	90.77	-8.27	-.82	-.58	-.15
431.953	-139868.5	44433.1	-1636.8	-357.98	89.05	-8.67	-.89	-.65	-.15
433.874	-140558.6	44602.9	-1653.6	-359.83	87.74	-8.72	-.96	-.70	-.14
436.718	-141586.1	44849.2	-1679.5	-362.66	85.63	-9.30	-1.05	-.76	-.17
438.640	-142285.4	45012.2	-1697.7	-364.91	84.13	-9.62	-1.09	-.80	-.18
441.484	-143327.5	45247.9	-1725.8	-367.94	81.82	-10.20	-1.16	-.87	-.19
443.421	-144042.9	45404.5	-1745.9	-370.19	80.12	-10.44	-1.21	-.92	-.21
446.249	-145055.4	45626.9	-1776.7	-373.82	77.23	-11.20	-1.32	-.99	-.23
448.187	-145822.4	45774.7	-1798.8	-376.37	75.43	-11.61	-1.40	-1.05	-.25
451.031	-146899.2	45984.2	-1832.9	-380.60	72.34	-12.37	-1.50	-1.14	-.25
452.953	-147623.6	46120.7	-1857.0	-383.46	70.06	-12.79	-1.57	-1.23	-.24
455.796	-148731.1	46314.3	-1894.4	-388.09	66.39	-13.55	-1.69	-1.35	-.25
457.718	-149480.5	46439.1	-1920.9	-391.34	63.71	-13.87	-1.79	-1.44	-.27
460.562	-150601.7	46613.7	-1961.9	-395.77	59.45	-14.82	-1.94	-1.55	-.30
462.484	-151368.2	46724.6	-1990.9	-400.43	56.39	-15.41	-2.05	-1.63	-.31
465.328	-152516.3	46877.8	-2036.0	-406.66	51.54	-16.36	-2.18	-1.78	-.30
467.249	-153302.4	45972.8	-2067.8	-410.82	48.19	-16.78	-2.30	-1.90	-.30
470.093	-154480.9	47100.9	-2117.1	-417.45	42.37	-17.72	-2.46	-2.06	-.34
472.015	-155288.7	47178.1	-2152.0	-422.51	38.33	-18.32	-2.62	-2.21	-.39
474.859	-156601.8	47277.2	-2206.2	-430.14	31.92	-19.63	-2.88	-2.38	-.45
476.781	-157334.4	47333.7	-2244.3	-435.80	27.10	-20.50	-3.11	-2.59	-.48
479.624	-158588.1	47399.1	-2305.3	-445.03	19.72	-21.99	-3.47	-2.93	-.51
484.406	-160759.6	47455.3	-2416.3	-461.93	5.18	-24.27	-3.73	-3.17	-.55

CONFIDENTIAL

GEMINI EDIT PROGRAM

COMPUTED POSITION, VELOCITY AND ACCELERATION IN GUIDANCE THRUST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*)	ZDDOT (FT/SEC*2)
487.234	-162094.7	47454.2	-2483.1	-473.37	-4.74	-26.12	-4.02	-3.41	-.59
489.171	-163911.7	47437.1	-2540.0	-481.93	-11.80	-27.27	-4.52	-3.80	-.68
491.171	-165785.5	47405.0	-2596.1	-491.19	-19.36	-28.78	-4.79	-4.07	-.70
494.249	-168521.4	47324.3	-2687.9	-506.33	-32.30	-30.91	-4.97	-4.34	-.72
498.323	-172155.5	47245.2	-2753.5	-518.89	-41.71	-32.42	-5.25	-4.55	-.72
498.421	-172260.4	47147.3	-2823.3	-527.74	-51.81	-33.93	-5.60	-5.00	-.74
501.499	-169334.1	46942.5	-2931.2	-545.69	-67.49	-36.24	-5.94	-5.31	-.73
503.578	-170422.9	46708.7	-3008.0	-558.55	-78.94	-37.75	-6.38	-5.72	-.74
505.656	-171658.8	46630.8	-3088.1	-572.01	-91.18	-39.18	-6.83	-6.17	-.80
508.734	-173454.1	46319.1	-3213.0	-593.56	-110.76	-41.59	-7.36	-6.61	-.88
510.823	-174715.3	46070.1	-3302.7	-609.63	-125.15	-43.92	-7.73	-7.15	-.99
512.906	-176003.4	45791.9	-3396.3	-626.63	-140.12	-45.80	-8.72	-7.86	-1.08
515.994	-177976.5	45318.5	-3543.1	-654.45	-165.36	-49.40	-9.29	-8.40	-1.10
518.078	-179372.9	44950.4	-3648.8	-674.82	-183.94	-51.85	-10.02	-9.13	-1.15
520.155	-180759.6	44546.0	-3758.9	-695.30	-203.20	-54.08	-10.76	-9.88	-1.20
523.218	-182986.9	43872.1	-3930.5	-730.16	-234.39	-57.69	-11.34	-10.50	-1.26
525.312	-184543.7	43394.5	-4054.5	-754.74	-257.65	-60.57	-11.91	-11.15	-1.28
527.397	-186140.6	42792.4	-4183.1	-780.42	-281.60	-63.29	-12.74	-12.09	-1.33
529.468	-187763.3	42177.3	-4317.5	-807.10	-306.91	-65.82	-13.44	-12.78	-1.32
532.546	-190346.0	41156.9	-4527.0	-849.08	-347.37	-70.25	-14.02	-13.42	-1.36
534.624	-192144.9	40412.3	-4675.7	-879.57	-376.00	-72.79	-14.82	-14.28	-1.42
536.703	-194007.4	39596.5	-4830.6	-910.96	-404.58	-75.97	-15.63	-15.19	-1.44
539.795	-197065.2	38250.4	-5073.2	-960.04	-454.44	-80.51	-16.48	-15.96	-1.67
541.874	-198943.5	37275.8	-5245.3	-995.74	-489.12	-83.51	-17.33	-17.15	-1.87
543.953	-201056.6	36218.0	-5429.2	-1033.53	-524.57	-89.04	-19.27	-18.48	-2.12
547.045	-204339.1	34517.0	-5708.8	-1095.54	-584.25	-95.04	-21.07	-20.53	-2.29
549.124	-206656.3	33253.1	-5912.2	-1139.64	-626.93	-100.05	-21.83	-21.18	-2.26
551.203	-209036.5	31899.1	-6125.3	-1185.75	-672.53	-104.96	-23.12	-22.56	-2.49
554.296	-212874.1	29703.7	-6452.2	-1259.57	-743.81	-112.25	-24.34	-23.70	-2.50
556.390	-215570.5	28087.8	-6704.3	-1311.39	-794.97	-118.72	-25.64	-25.06	-2.79
559.468	-219357.2	26376.0	-6956.4	-1366.91	-848.19	-123.02	-27.03	-26.65	-2.97
561.546	-222100.6	23523.7	-7353.7	-1450.75	-931.76	-134.12	-28.50	-28.02	-3.18
563.640	-225811.5	21606.6	-7641.0	-1512.28	-993.16	-139.79	-30.48	-29.87	-3.51

CONFIDENTIAL

April 3, 1965

GEMINI EDIT PROGRAM

COMPUTED POSITION, VELOCITY AND ACCELERATION IN GUIDANCE TERRAIN COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT FT/SEC*2)
565.719	-229028.5	19472.1	-7941.4	-1578.41	-1056.33	-148.08	-32.45	-31.77	-3.65
568.795	-234052.1	16056.3	-8414.3	-1681.47	-1156.58	-159.56	-33.85	-33.21	-3.78
570.890	-237651.2	13554.8	-8756.6	-1753.12	-1228.91	-167.71	-34.98	-35.12	-3.72
572.984	-241404.9	10898.0	-9115.0	-1829.07	-1303.58	-175.02	-36.69	-37.22	-3.60
575.062	-245289.0	8150.9	-9485.8	-1904.42	-1383.72	-182.80	-38.22	-38.75	-3.69
578.140	-251345.0	3650.4	-10066.9	-2024.71	-1504.36	-193.25	-39.66	-40.44	-3.82
580.218	-255647.2	427.2	-10479.1	-2110.48	-1590.15	-202.67	-41.50	-42.16	-3.99
582.295	-260127.7	-2975.8	-10903.1	-2197.15	-1680.72	-210.47	-43.37	-43.88	-4.16
585.374	-267109.6	-8365.6	-11573.5	-2332.36	-1818.05	-223.66	-44.82	-45.21	-4.51
587.463	-272103.0	-12278.1	-12058.5	-2430.44	-1913.11	-232.37	-47.19	-46.86	-4.82
589.546	-277252.1	-16353.8	-12555.2	-2528.02	-2012.75	-245.60	-49.59	-48.97	-5.09
592.624	-285291.6	-22797.3	-13331.1	-2684.96	-2165.20	-259.54	-51.89	-51.25	-5.33
594.703	-290394.1	-27421.5	-13893.9	-2795.56	-2275.18	-270.81	-54.06	-53.74	-5.18
596.781	-296937.4	-32275.3	-14457.9	-2910.36	-2388.10	-283.07	-55.88	-55.85	-5.04
599.859	-306159.9	-39919.1	-15347.7	-3085.13	-2567.07	-298.24	-57.16	-59.56	-4.58
601.953	-312750.2	-45441.8	-15976.7	-3205.76	-2696.37	-306.01	-58.55	-62.89	-3.56
604.015	-319458.4	-51161.8	-16611.3	-3327.99	-2830.35	-313.52	-60.44	-66.64	-2.56
607.103	-330091.3	-60248.3	-17586.9	-3515.21	-3036.83	-319.70	-61.48	-68.08	-2.16
609.187	-337537.6	-66718.3	-18253.7	-3645.86	-3182.32	-322.99	-63.09	-70.32	-1.55
611.265	-345255.2	-73490.7	-18927.3	-3778.32	-3330.55	-326.91	-64.65	-72.64	-1.09
614.343	-357260.1	-84099.0	-19933.2	-3979.16	-3555.95	-329.24	-65.96	-74.48	-.59
616.421	-365608.4	-91561.3	-20614.8	-4117.64	-3714.12	-329.75	-67.41	-76.74	.27
618.499	-374326.8	-99553.1	-21295.0	-4260.02	-3875.90	-328.46	-68.77	-78.94	1.14
621.578	-387771.8	-111869.3	-22295.0	-4473.21	-4121.50	-323.96	-69.83	-80.39	1.95
623.656	-397223.4	-120615.6	-22958.3	-4615.51	-4291.18	-318.71	-70.92	-82.08	3.00
625.734	-406980.1	-129716.0	-23609.6	-4768.11	-4462.33	-311.12	-71.85	-83.84	4.03
628.796	-421923.9	-143785.1	-24538.4	-4990.13	-4721.20	-297.70	-72.83	-85.21	4.71
630.874	-432453.3	-153780.4	-25142.5	-5140.65	-4901.41	-286.96	-73.70	-87.13	5.63
632.953	-443301.8	-164156.4	-25723.6	-5296.78	-5082.02	-274.87	-74.85	-88.80	6.26
636.015	-459877.6	-180159.0	-26533.4	-5525.73	-5358.54	-252.99	-76.13	-90.16	6.15
638.093	-471522.3	-191492.5	-27052.0	-5686.66	-5546.96	-240.55	-76.89	-91.31	5.39
640.171	-483518.0	-203219.5	-27546.9	-5848.80	-5737.90	-231.55	-78.04	-92.01	3.79
642.249	-495840.4	-215343.9	-28023.8	-6009.93	-5930.61	-224.98	-78.17	-92.67	3.07
645.328	-514711.3	-234038.7	-28703.9	-6253.47	-6215.51	-217.03	-78.08	-93.35	2.98

April 3, 1965

GEMINI EDIT PROGRAM

COMPUTED POSITION, VELOCITY AND ACCELERATION IN GUIDANCE TRUEST COORDINATES

TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
647.406	-527870.4	-247159.9	-29145.0	-6414.40	-6410.94	-211.10	-78.16	-93.88	3.87
649.484	-541367.9	-260686.9	-29570.2	-6573.94	-6607.16	-203.00	-78.12	-94.94	5.06
652.562	-561979.6	-281477.9	-30160.7	-6817.80	-6898.21	-184.31	-78.62	-96.24	6.07
654.624	-576207.3	-295916.7	-30524.9	-6980.05	-7100.57	-170.63	-79.40	-97.45	6.92
656.703	-590884.6	-310885.3	-30862.1	-7143.21	-7305.36	-155.32	-80.03	-96.97	7.50
659.751	-613271.3	-333845.7	-31302.4	-7392.89	-7609.10	-131.96	-81.03	-100.23	7.84
661.859	-628802.0	-349883.8	-31558.3	-7562.66	-7820.53	-114.49	-81.93	-101.70	7.82
663.921	-644577.3	-366237.0	-31778.1	-7732.43	-8032.93	-97.94	-82.41	-103.16	8.09
666.959	-668768.7	-391451.8	-32040.8	-7986.63	-8351.39	-75.41	-82.66	-103.48	8.49
669.078	-685543.2	-409030.0	-32174.2	-8158.41	-8565.94	-55.42	-82.54	-103.86	8.41
671.140	-702544.3	-426913.2	-32272.6	-8329.19	-8780.11	-34.72	-82.54	-104.27	7.80
674.218	-728571.7	-454441.9	-32357.6	-8582.09	-9102.95	-13.73	-82.95	-104.83	6.59
676.296	-746587.4	-473584.4	-32378.3	-8755.25	-9321.01	-3.14	-83.22	-105.20	5.42
678.374	-764981.7	-493181.8	-32374.3	-8929.71	-9539.17	6.72	-83.28	-105.52	5.42
681.437	-792654.5	-522892.9	-32323.0	-9185.41	-9863.77	21.93	-83.01	-106.12	6.34
683.515	-811955.6	-543620.4	-32254.1	-9356.18	-10084.75	38.11	-82.33	-106.62	7.45
685.593	-831576.9	-564810.6	-32155.4	-9526.16	-10306.52	56.82	-81.92	-107.23	8.17
688.656	-861132.0	-596879.6	-31946.4	-9775.76	-10635.51	81.69	-81.76	-107.90	8.08
690.749	-881773.4	-619387.5	-31761.4	-9946.74	-10860.97	97.14	-81.85	-108.86	7.19
692.812	-902469.8	-642024.3	-31548.5	-10116.12	-11088.20	113.77	-82.23	-110.04	6.01
695.850	-934000.0	-676580.0	-31183.5	-10369.32	-11427.32	129.95	-82.87	-111.15	4.82
697.968	-955729.2	-700671.5	-30909.4	-10543.69	-11661.37	137.26	-82.82	-111.72	4.09
700.046	-977815.7	-725145.3	-30615.6	-10716.45	-11893.66	142.32	-82.63	-112.30	4.35
703.124	-1011188.2	-762269.6	-30144.3	-10965.05	-12239.42	157.77	-82.42	-112.86	5.53
705.203	-1034159.4	-787969.5	-29795.6	-11140.43	-12474.83	171.23	-81.93	-113.38	7.29
707.281	-1057483.7	-814141.8	-29418.4	-11311.01	-12711.81	188.83	-81.37	-113.83	8.55
710.343	-1092499.4	-853604.3	-28794.6	-11559.54	-13060.59	217.01	-81.01	-114.23	9.35
712.421	-1116690.4	-880990.1	-28321.5	-11726.52	-13296.78	236.60	-79.79	-113.87	9.74
714.494	-1141040.5	-908655.1	-27810.5	-11892.11	-13535.32	258.18	-78.31	-113.27	10.25
717.562	-1178001.4	-950841.4	-26965.8	-12130.52	-13881.26	298.63	-77.05	-112.57	10.83
719.640	-1203366.1	-979923.3	-26337.2	-12288.31	-14114.72	312.83	-75.09	-110.60	11.33
721.718	-1229075.1	-1009480.3	-25656.5	-12442.49	-14342.92	338.04	-74.27	-108.54	12.22
724.796	-1267713.7	-1054130.0	-24559.2	-12665.49	-14675.01	374.11	-72.75	-107.37	12.21

April 3, 1965

GEMINI EDIT PROGRAM

COMPUTED POSITION, VELOCITY AND ACCELERATION IN GUIDANCE THRUST COORDINATES

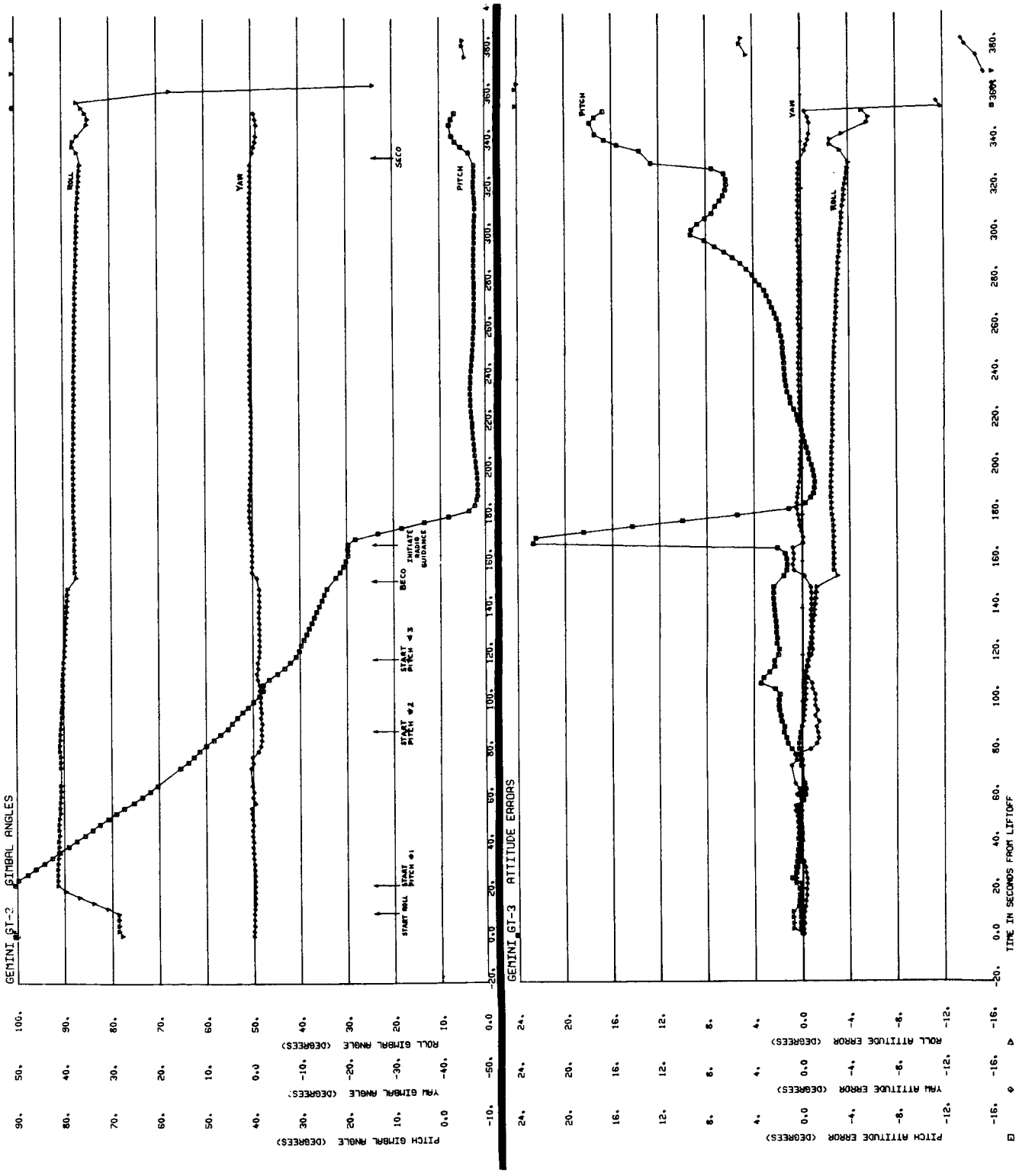
TIME (SECS)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)	XDDOT (FT/SEC*2)	YDDOT (FT/SEC*2)	ZDDOT (FT/SEC*2)
726.874	-1294185.4	-1084847.1	-23754.9	-12816.06	-14895.60	401.05	-71.78	-105.19	11.73
729.953	-1320969.7	-1116018.8	-22900.6	-12966.03	-15113.89	426.45	-70.51	-102.48	10.68
732.031	-1361201.1	-1163002.8	-21550.7	-13182.00	-15427.22	457.50	-69.16	-100.04	9.29
734.109	-1388729.0	-1195258.2	-20588.9	-13322.93	-15629.46	473.36	-66.53	-97.53	8.20
736.187	-1416540.3	-1227739.5	-19592.4	-13458.85	-15825.66	487.51	-60.30	-95.91	6.17
738.265	-1444615.6	-1261036.1	-18569.9	-13583.37	-16023.03	504.11	-55.40	-96.31	4.38
741.343	-1486644.9	-1310819.5	-17023.2	-13742.64	-16323.29	513.53	-50.97	-96.54	1.89
743.406	-1515076.1	-1344683.7	-15976.1	-13841.11	-16524.53	513.05	-46.77	-95.21	-.75
745.499	-1544144.7	-1379477.8	-14911.9	-13934.75	-16720.89	504.75	-43.21	-92.80	-2.06
748.578	-1587221.2	-1431366.4	-13361.0	-14066.75	-17004.17	498.76	-40.28	-90.21	-1.78
750.656	-1615514.0	-1466976.9	-12321.2	-14144.58	-17188.82	496.26	-35.72	-86.51	.03
752.734	-1645967.9	-1502764.4	-11284.0	-14214.40	-17362.85	496.30	-31.17	-82.35	1.21
755.812	-1689841.2	-1556576.3	-9740.6	-14303.58	-17613.44	506.08	-27.88	-79.35	1.69
757.890	-1719608.5	-1593327.8	-8688.9	-14358.37	-17772.93	507.77	-24.37	-75.70	2.29
759.968	-1749484.3	-1630410.8	-7626.8	-14403.66	-17925.88	510.20	-21.15	-72.05	2.35
763.046	-1793904.6	-1685910.1	-6037.4	-14466.29	-18144.48	522.03	-18.73	-69.78	2.60
765.124	-1823991.1	-1723749.3	-4950.7	-14501.67	-18285.43	526.47	-15.88	-66.61	2.78
767.171	-1853696.1	-1761303.3	-3868.1	-14530.83	-18419.36	530.10	-12.80	-62.99	2.34
770.218	-1898009.6	-1817692.9	-2239.2	-14566.82	-18608.50	540.09	-10.08	-60.19	2.26
772.281	-1928098.2	-1856179.7	-1125.3	-14584.65	-18726.14	542.58	-7.35	-56.96	2.03
774.343	-1958140.4	-1894912.2	-2.7	-14592.58	-18839.38	546.61	-4.20	-53.92	1.12
777.374	-2002389.4	-1952257.3	1651.0	-14607.73	-19002.19	551.59	-2.32	-52.18	-.54
779.437	-2032507.6	-1991546.7	2774.3	-14604.93	-19105.77	548.68	-1.20	-50.00	-1.92
781.499	-2062632.6	-2031051.5	3891.5	-14606.81	-19207.50	534.50	.82	-48.15	-3.76
784.531	-2106895.6	-2089482.7	5504.7	-14607.21	-19349.33	530.84	2.08	-46.83	-4.30
786.593	-2137002.0	-2129482.4	6579.3	-14596.48	-19447.74	515.85	4.45	-44.36	-4.09
788.656	-2167091.1	-2169673.0	7638.7	-14584.95	-19536.01	506.75	7.08	-41.96	-4.58
791.703	-2211481.5	-2229375.4	9166.4	-14563.10	-19658.71	495.72	9.70	-40.07	-3.88
793.765	-2241479.2	-2270001.0	10180.8	-14540.56	-19739.56	486.45	12.27	-39.04	-3.45
796.796	-2285474.9	-2330009.9	11643.9	-14495.59	-19857.47	476.35	15.26	-38.07	-3.33
798.859	-2315304.9	-2370913.9	12627.4	-14461.54	-19934.13	472.59	17.49	-37.41	-2.57

CONFIDENTIAL

Appendix III

ASCENT GIMBAL ANGLES AND ATTITUDE ERRORS

Figure 22


GEMINI GT-2 GIMBAL ANGLES
ROLL
YAW
PITCH
SECO
BECO
INITIATE INDUCE GUIDANCE
START PITCH #3
START PITCH #2
START PITCH #1
START ROLL
ROLL GIMBAL ANGLE (DEGREES)
YAW GIMBAL ANGLE (DEGREES)
PITCH GIMBAL ANGLE (DEGREES)
GEMINI GT-3 ATTITUDE ERRORS
ROLL ATTITUDE ERROR (DEGREES)
YAW ATTITUDE ERROR (DEGREES)
PITCH ATTITUDE ERROR (DEGREES)
TIME IN SECONDS FROM LIFTOFF