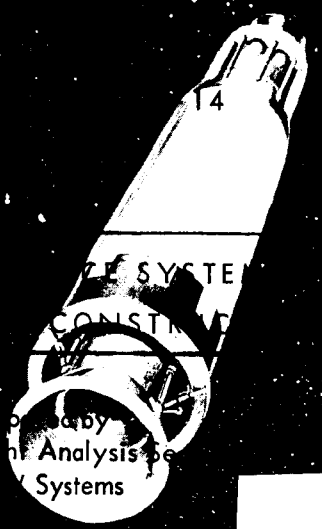
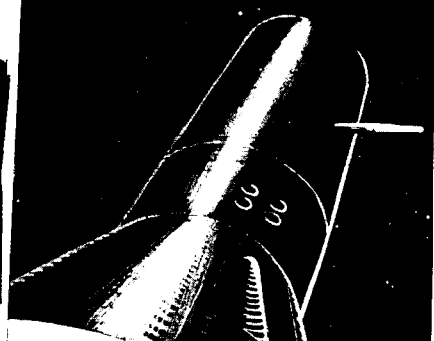
MSC-G-R-66-7
Supplemental Report 4





Issued as: Supplemental Report 4
To: Gemini Program Mission Report
Gemini X
MSC-G-R-66-7
By: Gemini X Mission Evaluation Team
National Aeronautics and Space Administration
Manned Spacecraft Center
Houston, Texas

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05952-6088-R800

Total Pages: 115

TRW NOTE NO. 66 FMT-270

MSC-G-R-66-7
Supplemental Report 4

PROJECT GEMINI
TASK MSC/TRW G-14

C67-8752

GEMINI 10 INERTIAL GUIDANCE SYSTEM EVALUATION AND TRAJECTORY RECONSTRUCTION (U)

3 JANUARY 1967

Issued as:
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To:
Gemini Program Mission Report
Gemini X
MSC-G-R-66-7

By:
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National Aeronautics and Space Administration
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ABSTRACT

This report contains a detailed evaluation of the Gemini 10 inertial guidance system accuracy during the ascent and reentry phases of the mission. An analysis of the external tracking instrumentation accuracy during ascent is also included. The results of the error analyses are used to construct a reference Gemini 10 trajectory for the ascent and reentry portions of the mission.

The reconstructed relative trajectory between the Gemini and Agena 10 vehicles is compared to the Gemini 10 onboard radar measurements and the residuals evaluated. The measurements of the altitudes of various stars by the astronaut, using a hand-held sextant, are compared to calculated values.

This TRW supplemental report, the IBM supplemental report, and the NASA/MSC Gemini 10 Mission final report represent the complete approved inertial guidance system analysis accomplished on this mission.

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ILLUSTRATIONS (Concluded)

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1. INTRODUCTION AND SUMMARY

The Gemini 10 flight was launched on 18 July 1966 from Complex 19 at Cape Kennedy, Florida. This report, which has been prepared for the NASA Manned Spacecraft Center by TRW Systems in response to Task MSC/TRW G-14 of the Gemini Mission Trajectory Control Program, presents TRW's best estimate of the inertial guidance system (IGS) accuracy performance during the ascent, orbit and reentry phases of its operation on the Gemini 10 flight. Also presented are analysis results of the rendezvous radar performance and sextant sightings taken during the mission. This report constitutes an addendum to the Gemini 10 NASA/MSC Gemini Program Mission Report, Reference 6.

The basic data reduction and techniques of analysis used to obtain the conclusions in this report are defined in detail in the TRW Analysis Plan and Accuracy Prediction reports, References 1 and 2 respectively. The following is a brief summary of the analysis results.

a) The TRW estimate of total IGS error at SECO + 20 seconds is:

$\Delta x = 1380 \pm 200$ ft	$\Delta \dot{x} = -0.3 \pm 1$ ft/sec
$\Delta y = 1810 \pm 500$	$\Delta \dot{y} = 13.5 \pm 3$
$\Delta z = 450 \pm 300$	$\Delta \dot{z} = 3.9 \pm 3$

The uncertainties are engineering judgments and equivalent to one sigma error estimates.

b) **A set of IGS and tracking system error source coefficients was derived from analysis of position and velocity comparisons between IGS telemetry and tracking system data. Recovered IGS error sources that contributed significantly to the explanation of the observed differences were:**

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Error source	Coefficient	Velocity error contribution in IGS coordinates at SECO + 20 sec (ft/sec)
x-axis		
No significant contributor		
y-axis		$\dot{\Delta y}$
X accelerometer bias	46.6 ±10 ppm g	-1.2
Z accelerometer bias	76.9 ±10 ppm g	0.9
Z accelerometer scale factor	-451 ±66 ppm g	3.1
Y gyro constant drift rate	0.35 ±0.16 °/hr	9.3
Y gyro input axis unbalance	-0.044 ±0.08 °/hr/g	-1.2
Platform misalignment about Y accelerometer axis	17 ±31 sec	2.0
z-axis		$\dot{\Delta z}$
X gyro input axis unbalance	-0.41 ±0.12 °/hr/g	5.0
X gyro spin axis unbalance	0.14 ±0.14 °/hr/g	-1.3
Z gyro constant drift rate	0.20 ± 0.13 °/hr	2.8
Z gyro input axis unbalance	-0.038 ±0.074 °/hr/g	-1.3
Platform misalignment about X accelerometer axis	36 ±13 sec	-3.9
IGS azimuth misalignment	19.8 ±10 sec	2.4

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c) Significant tracking system bias errors recovered from the analysis were:

MISTRAM I	Coefficient	Velocity error contribution in IGS coordinates at SECO + 20 sec (ft/sec)
P_{100K} bias	-0.50 ± 0.10 ft	$\Delta\dot{y}$ = 6.5
GE/MOD III		
Refraction	-4.4 ± 2.2 n units	$\Delta\dot{y}$ = 4.4

d) The TRW estimate of the IGS error during reentry at guidance termination (76, 000 ft) is:

0 ± 0.3 n.mi.downrange

-4.9 ± 0.3 n.mi.crossrange (south)

-3.3 ± 0.3 n.mi.altitude (low)

Approximately 80 percent of the apparent IGS error is estimated to be due to initial platform misalignment at retrofire.

e) The TRW estimate of the reentry trajectory miss from the intended splashdown point is:

5.1 ± 0.5 n.mi.downrange (long)

2.9 ± 0.5 n.mi.crossrange (north)

f) The following conclusions were reached as a result of the rendezvous radar evaluation:

- During the radar tracking interval preceding platform alignment (208 to 224 minutes GET) radar/platform angle error trends of up to 3 degrees were evident. The error was most likely in the radar measurement.
- During platform alignment, the azimuth angle residuals showed excursions of ±3 degrees, indicating possible problems in alignment. [MSC analysis indicated the platform was momentarily torqued out of alignment due to a spacecraft roll error.]

- After platform alignment, there is an indicated platform/radar system misalignment: yaw/azimuth misalignment = -1.9 ± 0.5°, pitch/elevation misalignment = -0.6 ● 0.5°.
- No radar range error is evident to within the accuracy of the trajectory reconstruction, 1000 to 3000 feet.

Sections 2 and 3 contain details of the ascent and reentry IGS analysis and trajectory reconstruction. The trajectory listings are contained in Appendixes A and B. An analysis of the quality of the external tracking data obtained during ascent is contained in Section 4, and includes plots of the residuals of each tracking system compared to the reconstructed trajectory. A discussion of tracking system calibration data is contained in Appendix C. Section 5 discusses the comparison made between telemetered rendezvous radar measurements and TRW calculated values. Sextant sighting measurements are compared to calculated values in Section 6.

2. INERTIAL GUIDANCE SYSTEM PERFORMANCE ANALYSIS AND ASCENT TRAJECTORY RECONSTRUCTION

This section provides an evaluation of the performance of the IGS during the Gemini 10 ascent flight phase. The evaluation was accomplished by making comparisons of telemetered IGS quantities and external tracking data and conducting visual and regression analyses on the residuals of the comparisons.

Cartesian comparisons (sensed, total, and delta-delta) were made for display and visual analyses. These were referenced to the IGS computer coordinate system which is an inertial, orthogonal right-handed system referenced to the center of the earth. The x and z axes lie in a plane parallel to the geodetic tangent plane at the launch site at platform release time, with the x axis defined by the launch azimuth (actually the misaligned azimuth) positive down range. The y axis is positive down along the geodetic vertical, and the z axis is directed so as to complete the right-handed x, y, z set.

Sensed comparisons (Figure 2-1) were generated by scaling and biasing accumulated accelerometer count data and comparing the result with external tracking data adjusted for gravity and transformed to IGS coordinates. The Gemini 10 IGS measured quantities were compensated in flight with preflight measured IMU error sources; therefore, postflight IGS/tracker comparisons were generated with similarily compensated IGS sensed velocities. Section 2. 2. 1 provides a discussion of the compensations and their effects. The differences of the sensed coordinate IGS/tracker comparisons are attributable to residual uncompensated IMU errors, external tracking system errors, and initial alignment errors.

Total inertial comparisons, Figures 2-2 and 2-3, were generated by differencing telemetered total position and velocity outputs from the airborne computer with external tracking data. In addition to IMU, tracking data, and alignment errors, these comparisons include airborne computer navigation errors. These are caused by gravity computation errors, which result from numerical approximations and IMU position errors, and by computational errors due to truncation, etc. The navigation errors were

extracted by differencing the sensed and inertial comparison sets to form delta-delta comparisons (Figures 2-4 and 2-5).

Position and velocity comparisons were also made in the external tracking system measurement coordinates. These were made for the purpose of isolating uncompensated IGS and tracking system error source coefficients by performing visual and computer regression analyses of the differences. External tracking data used in the evaluation included Quick-Look MISTRAM I 10K and 100K and GE/MOD III. Tracking data constants and corrections are presented in Appendix C.

External tracking data used for complementary analyses included MISTRAM Final and AFETR Final BET data. The results of analysis of these data sources are presented in Table 4-1 of Section 4.

Support in the estimation of the total IGS error was obtained from a comparison of the IGS position and velocity vector at SECO +20 seconds with a similar vector derived from an orbital BET propagated back to SECO +20. The details of this comparison are given in Section 2.1.1.

All ascent-phase plots enclosed are referenced to liftoff time (22h 20m 26.648s GMT), which occurred 3.260 seconds after IGS platform release.

2.1 INERTIAL GUIDANCE SYSTEM ERROR

The estimated IGS errors following the end of the powered ascent phase (SECO+20 seconds, 360 seconds from liftoff) are contained in Table 2-1. The column headed "IMU and Alignment Error" represents the error contributed by the accelerometer, gyro, and initial platform alignment sources; the column titled "Navigation Error" is the contribution of various approximations within the airborne computer as observed from the delta-delta comparisons; and the "Total IGS Error" column is the sum of the two and represents the total IGS error. The column titled "TRW Orbit 1 Reconstruction" is the guidance error estimated from a comparison at SECO +20 seconds between the IGS data and the free flight reconstruction of Revolution 1 propagated back to insertion. Details of the reconstructed trajectory are given in Section 2.2.1. An additional column titled "NASA 30-Day Report" lists the values representing the NASA/MSC estimates of IGS errors. The ± numbers listed are one-sigma uncertainty

estimates. They are the result of the analysis of the MOD III, MISTRAM and free flight trajectory estimations, and the statistical error regression.

Table 2-1. IGS Errors at SECO +20 Seconds

Observation	TRW Ascent Data Analysis			TRW orbit 1 reconstruction	NASA 30-day report
	IMU and alignment error	Navigation error	Total IGS error	Total IGS error	Total IGS error
$\dot{X}$ ft/sec	0.3±1.0	-0.6±0.1	-0.3±1.0	-0.3±2.0	0±1.0
$\dot{Y}$ ft/sec	13.3±4.0	0.2±0.1	13.5±4.0	16.0±3.0	15.5±3.0
$\dot{Z}$ ft/sec	4.3±2.0	-0.4±0.1	3.9±3.0	6.9±3.0	5.4±2.0
X ft	1280±200	95±5	1375±200	918±300	545±100
Y ft	1860±500	-48±5	1812±500	2020±600	2450±100
Z ft	460±300	-9±5	451±300	308±600	440±50

2.1.1 Free-Flight Fix

A comparison between the IGS position/velocity vector at SECO +20 seconds and a position/velocity vector derived from a trajectory reconstruction of the flight interval from insertion to first rendezvous was made to support the total IGS error estimation. This comparison point is indicated by a large X on Figures 2-1, 2-2, 2-3 and 2-9 at 360 seconds. (The position and velocity comparisons presented in this report were generated excluding a timing error of 0.0485 second in the IGS data. This timing error causes a position error at SECO +20 seconds of 1200, - 330, 10 feet in IGS coordinates. The "TRW ascent data analysis" in Table 2-1 includes this error but the plotted "TRW orbit 1 reconstruction" comparison does not, so as to make it consistent with the "ascent" comparison plots.) This orbit reconstruction utilized tracking data for spacecraft revolutions 1 through 3 and IGS sensed velocity measurements of maneuvers executed during this flight phase. The trackers, which follow, provided C-band tracking data consisting of range, azimuth, and elevation observations.

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Station	Revolutions
Antigua	1, 2
Ascension	1, 2
Pretoria	1, 3
Carnarvon	1, 2
California	1, 2, 3
Hawaii	1, 2, 3
White Sands	1, 2
Eglin	1
Merritt	1
Grand Bahama	2
Grand Turk	3

The following IGS measured maneuver parameters were considered in the reconstruction.

Maneuver	Burn initiation time (GET) (hr:min:sec)	Velocity Increment in IGS coordinates			
		$\Delta\dot{X}$ (ft/sec)	$\Delta\dot{Y}$ (ft/sec)	$\Delta\dot{Z}$ (ft/sec)	Burn duration (sec)
Separation	00:06:11	1.5	0.6	-0.8	19
IVAR	00:06:47	26.2	-0.62	0.5	36
Phase adjust	02:18:08	55.2	-1.2	1.2	77
Plane change	02:30:46	0.4	-0.5	-11.0	12
Coelliptical	03:47:35	47.1	-5.9	-0.3	93.9
Terminal phase initiation (TPI)	04:33:42	37.1	-20.0	0.2	60

The TRW reconstructed state vector at SECO +20 seconds (361.5 seconds GET) in IGS coordinates was:

$X = 3,974,910$ ft $\quad \dot{X} = 25,265.64$ ft/sec

$Y = -21,066,644$ ft $\quad \dot{Y} = 4,763.24$ ft/sec

$Z = -94,789$ ft $\quad \dot{Z} = -81.14$ ft/sec

The uncertainty associated with the orbit reconstruction vector, in Table 2-1, is an engineering estimate based on an examination of the radar residuals to the TRW BET and the uncertainty associated with integrating the BET from the free-flight phase back through the IVAR and Separation maneuvers. Further details of the orbit reconstruction can be found in Reference 3.

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2.1.2 Insertion Conditions

The IGS error magnitudes indicated in Table 2-1 under "TRW ascent data analysis" give the following trajectory referenced errors:

Velocity magnitude error = 1.8 ft/sec (IGS too large)

Flight path angle error = -0.024 deg (IGS velocity vector below trajectory)

Out-of-plane velocity error = 3.9 ft/sec (IGS left of trajectory).

Estimates of insertion conditions as determined from real time MISTRAM and GE tracking data are presented in Table 2-2. For comparison, the values derived from the TRW BET are also presented.

Table 2-2. Insertion Conditions (SECO +20 Seconds)

Observation	TRW BET	IGS	MISTRAM		GE MOD III	
			Real time	Final	Real time	Final
Velocity magnitude (ft/sec)	25711.8	25713.6	25716	25712	26693	25707
Flight path angle (deg)	-0.001	-0.025	-0.07	-0.035	+0.14	-0.021

2.2 INERTIAL MEASUREMENT UNIT ERROR ANALYSIS

2.2.1 Preflight Compensation

The Gemini 10 IMU measured quantities were compensated inflight analytically with preflight measured gyro drift error coefficients. The drift errors used for compensation and their contributions to the total IGS compensation are listed in Table 2-3. Also presented are the total observed error and the error which would have been present without compensation. The gyro preflight calibration history plots, Figures 2-6 through 2-8, suggest that a logical set of gyro drift coefficients was chosen and no logical process for deriving a better preflight compensation set based upon the calibration histories is apparent. Two postflight gyro coefficient calibrations are also plotted in these figures.

Table 2-3. IMU Error Compensation

Error Source	Units	Coefficient	Contribution to IGS error compensation at SECO +20 seconds		
			$\dot{X}$(ft/sec)	$\dot{Y}$(ft/sec)	$\dot{Z}$(ft/sec)
X gyro constant drift rate	°/hr	0.17	-0.02	0.00	-1.63
Y gyro constant drift rate	°/hr	-0.24	-0.21	-6.45	0.00
Z gyro constant drift rate	°/hr	-0.06	0.00	0.00	-0.83
X gyro input axis unbalance	°/hr/g	0.29	-0.04	-0.05	-3.58
Y gyro input axis unbalance	°/hr/g	0.10	0.35	2.75	0.00
Z gyro input axis unbalance	°/hr/g	-0.29	0.09	0.00	-10.05
X gyro spin axis unbalance	°/hr/g	-0.55	0.04	-0.11	5.05
Y gyro spin axis unbalance	°/hr/g	0.06	0.00	0.07	0.00
Z gyro spin axis unbalance	°/hr/g	-0.29	-0.01	0.00	2.18
	Total compensation		+0.20	-3.79	-8.86
	Error with compensation		+0.3	+13.3	+4.3
	Error without compensation		+0.50	+9.5	-4.6

Table 2-4 contains the TRW estimate of IMU error on Gemini flights 6 through 10, and provides an indication of the effect preflight gyro drift error compensation would have had on these flights if it had been utilized. Gemini 10 was the first flight to incorporate the ability to compensate inflight for preflight estimated gyro drift errors. The summary indicates no significant reduction of errors would have been achieved by compensation with the NASA/Honeywell preflight estimated coefficients. However, the preflight coefficients estimated for flights 6 through 9 were based primarily on single platform calibrations prior to flight, whereas the

Table 2-4. TRW Estimates of Gemini IMU Errors at SECO +20 Seconds With and Without Gyro Drift Error Compensation

Flight No.		TRW Estimates of IMU Error at SECO +20 Seconds			
		$\dot{X}$ (ft/sec)	$\dot{Y}$ (ft/sec)	$\dot{Z}$ (ft/sec)	$\dot{Z}'$ (ft/sec)**
6	As flown	-1.81	9.7	-1.92	-0.22
	Honeywell Preflight value	-0.87	-6.6	+0.54	+0.54
	With compensation	-0.94*	16.3	-2.46	-0.76
7	As flown	+5.6	+9.9	+0.2	-2.4
	Honeywell Preflight value	+0.7	+4.1	-6.2	-6.2
	With compensation	+4.9*	+5.8*	+6.8	+3.8
8	As flown	+5.18	-4.86	+11.35	+4.34
	Honeywell Preflight value	+0.03	-0.55	+7.65	+7.65
	With compensation	+5.15*	-4.31*	+3.70*	-3.31*
9	As flown***	+8.60	-1.63	8.31	2.54
	Honeywell Preflight value	+0.39	+3.43	-1.29	-1.29
	With compensation	+8.21*	-5.06	9.60	3.83
10	Without compensation	+0.50	+9.5	-4.6	-7.0
	Compensation	0.20	-3.79	-8.86	-8.86
	With compensation (as flown)	+0.3*	+13.3	+4.3*	+1.9*

*Error improved or unaffected by compensation
**Z' = Crossrange error with the effects of IGS/Burroughs azimuth alignment update error removed
***Gemini 9 error listed assumes IGS/Burroughs inflight azimuth update was successfully completed. Actual error was 166 f.p.s. in $\dot{Z}$.

actual compensations used for Gemini 10 were based upon the complete history of Gemini 10 platform calibrations.

It is observed that the crossrange ($\dot{Z}'$) error, adjusted for the Burroughs azimuth update error, is generally smaller than the vertical ($\dot{Y}$) error. There is no apparent reason for this difference based on the gyro drift error propagations. It could be explained by assuming that initial platform misalignment was the major system error source, since the

azimuth update procedure nulls out the crossrange component of this error source but not the downrange component. Accelerometer scale factor error also is a contributor to the vertical error but not the crossrange error.

Table 2-5 provides a comparison of the TRW proposed Gemini 10 total IMU errors (compensation + residuals) with error magnitudes derived from both preflight and postflight calibration data. As noted from Table 2-4, there has not been consistent agreement between preflight IMU calibration data and TRW postflight error estimation based on the apparent flight performance. Generally, there has not been a postflight IMU calibration to check on instrument stability.

Table 2-6 shows the velocity error propagation of the differences between the September 23 postflight calibration and the preflight estimated (and flown) coefficients. The shift in the Y gyro constant drift rate(YGCDR)term is 0.22 deg/hr, equivalent to 6 ft/sec y velocity error at SECO. This shift is in remarkably good agreement with the 0.35 deg/hr shift indicated by the TRW regression as the cause of the observed flight error in the vertical direction (see Table 2-8).

This correlation does not show up so obviously for the other large gyro coefficient shift called for by the postflight regression: X gyro input axis unbalance equal to -0.41 deg/hr/g. There are, however, sizeable shifts evident in the postflight X gyro calibrations for the constant drift (-0.2 deg/hr) and spin axis unbalance drift (0.1 deg/hr/g).

If sizeable and unpredictable coefficient shifts are measured across the flight test, it would seem conceivable that different and even larger shifts might be apparent during the very dynamic flight test. This is not to contend that the postflight statistical regression on the IGS/tracker residuals gives absolutely reliable results. In fact, the error separation is very seriously limited by the nigh correlation among the velocity error propagations of the possible error sources. However, the regression does select a statistically "best" fit when given the available data, error model, and related statistics. The most that can be hoped for from the flight profile of Gemini 10 is a reasonable indication of the likely error sources.

Table 2-5. IMU Error Coefficients

Error sources (TRW symbols)	Units	Preflight Platform Calibrations									Flight Compensation		Postflight platform calibrations	
		24 Feb	14 June	15 June	16 June	17 June	20 June	29 June	15 July	Preflight average	NASA/ Honeywell preflight estimated	TRW postflight estimated	23 Sept	26 Sept
XGCDR	°/hr	0.135	0.185	0.163	0.19	0.14	0.207	0.15	0.111	0.160	0.17	0.157 ± 0.19	-0.025	-0.023
XGIAU	°/hr/g	0.23	0.253					0.287	0.293	0.265	0.29	-0.126 ± 0.12	0.341	0.348
XGSAU	°/hr/g	-0.24	-0.485	-0.52	-0.592	-0.508	-0.567	-0.55	-0.561	-0.502	-0.55	-0.412 ± 0.14	-0.449	-0.452
YGCDR	°/hr	-0.135	-0.222					-0.244	-0.251	-0.213	-0.24	0.107 ± 0.16	-0.02	-0.01
YGIAU	°/hr/g	-0.07	-0.025					0.136	0.102	0.036	0.10	0.056 ± 0.08	0.122	0.042
YGSAU	°/hr/g	0.14	-0.003					0.114	-0.009	0.06	0.06	0.071 ± 0.20	-0.125	-0.184
ZGCDR	°/hr	-0.014	-0.0611					-0.048	-0.041	-0.041	-0.06	0.14 ± 0.13	-0.008	0.004
ZGIAU	°/hr/g	0.06	-0.273					-0.3	-0.251	-0.191	-0.29	-0.33 ± 0.07	-0.278	-0.278
ZGSAU	°/hr/g	-0.06	-0.286					-0.308	-0.176	-0.208	-0.29	-0.36 ± 0.09	-0.221	-0.223
Deviation from loaded value														
XSF	ppm	-31	0					-23	-103	-39	(1)	-46 ± 114		
YSF	ppm	-30	0					130	-117	-4.3	(1)	(1)		
ZSF	ppm	-240	0					78	18	-36	(1)	-451 ± 65		
BX	ppm g	38	0							19	(1)	46 ± 20		
BY	ppm g	57	-3							28	(1)	0 ± 20		
BZ	ppm g	-30	12							-9	(1)	77 ± 20		

(1) No change made from previously loaded values.

Table 2-6. Expected IGS Error From Postflight Calibrations

Error source	Units	Postflight minus preflight	Error at SECO + 20 seconds		
			$\Delta\dot{x}$(ft/sec)	$\Delta\dot{y}$(ft/sec)	$\Delta\dot{z}$(ft/sec)
XGCDR	o/hr	-0.195	0.02		1.88
XGIAU	o/hr/g	0.051	-0.008	-0.008	-0.642
XGSAU	o/hr/g	0.101	-0.007	0.02	-0.93
YGCDR	o/hr	0.22	0.19	5.9	
YGIAU	o/hr/g	0.022	0.08	0.6	
YGSAU	o/hr/g	-0.185	-0.16	-0.2	
ZGCDR	o/hr	0.052	-0.007		0.73
ZGIAU	o/hr/g	0.012	-0.004		0.42
ZGSAU	o/hr/g	0.069			-0.52
		Total	0.11	6.3	0.94

Table 2-7. TRW Estimates of Gemini Timing Errors

Flight No.	Time correlation (sec)	IGS clock drift (ppm)
3	-0.005	0
4	-0.002	30
5	0.014	-60.5
6	0.015	-63
7	0	-32.2
8	0.025	-90
9	0.017	-63
10	0.006*	-85
Mean	+0.009	-45.0

*0.0485 second known TRS bias removed.

2.2.2 Residual IMU Error After Compensation

Recovery of the IMU error source coefficients, which existed after compensation, was accomplished by visual analysis and by performing computer statistical regressions on IGS/tracker residuals. Figure 2-1 presents sensed velocity comparisons compensated for preflight estimated IMU errors, and a 0.0485 second TRS bias error. The IMU error source coefficients recovered as a result of the analysis are presented in Table 2-8.

2.2.2.1 Timing Error

The first set of velocity comparisons generated showed -5.3 and -5.6 ft/sec jumps in the x velocity residual at booster engine cutoff (BECO) and sustainer engine cutoff (SECO). This error trend indicated large IGS timing errors. Conversations with NASA MSC personnel revealed that 0.0485 second of the observed time correlation error was explained by a known time reference system (TRS) bias. The majority of the time correlation error was therefore identified; however, the remaining trend, obvious in Figure 2-1 from the small jumps at BECO and SECO, called for an additional 0.006 m sec time correlation error and an 85 part per million (ppm) clock drift error. Although the timing error results in zero sensed velocity error after SECO, where the thrust acceleration goes to zero, a relatively large x total position error of 1000 feet does remain after burnout. The Gemini 10 time correlation and clock drift error are compared with timing errors recovered from previous Gemini flights in Table 2-7. The summary indicates that the Gemini 10 timing errors are consistent with timing errors observed on previous flights. The clock drift is large however.

2.2.2.2 Accelerometer Bias Error

Accelerometer bias errors were determined from plots of IGS sensed velocities during free flight intervals of Revolution 4 and later during the free flight period after retrofire. The following bias errors were determined:

	Revolution 4	Post Retrofire
X accelerometer bias	46.6 ± 10 ppm g	6.2 ± 10 ppm g
Y accelerometer bias	0 ± 10 ppm g	43.6 ± 10 ppm g
Z accelerometer bias	76.9 ± 10 ppm g	46.9 ± 10 ppm g

The values calculated from Revolution 4 were used for the ascent phase analysis and those recovered from the post retrofire data were used for the reentry analysis.

2.2.3 Error Coefficient Recovery

The IMU error source coefficients presented in Table 2-8 were recovered by first determining accelerometer bias errors, compensating the IGS/tracker comparisons for these, and then performing statistical regression analysis on the residuals of the comparisons. The regression domain chosen was the following:

10K MISTRAM $\dot{P}$, $\dot{Q}$, $\dot{R}_{SUM}$

100K MISTRAM $\dot{P}$, $\dot{Q}$

GE MOD III (GE processed) R, A, E, $\dot{R}$, $\dot{P}$, $\dot{Q}$

The error model presented in Table 2-9 was selected to recover coefficients for most of the IMU error sources estimated by platform ground calibration tests. The terms preceded by an asterisk were recovered visually and were consequently not solved in the regression solution. However, the estimated uncertainty in their determination was statistically accounted for in the output coefficient uncertainties.

Several variations or combinations of error terms were considered in initial regression attempts which considered accelerometer and platform misalignments as being dominant error sources rather than gyro drift errors. None of these provided satisfactory fits to the IGS/tracker residuals, however. Satisfactory explanations of the residuals were achieved only when pitch-drift type error sources were included in the total error model.

Table 2-8. IGS Error Source Summary

IMU error source	Units	TRW Analysis					NASA 30-day Report							
		Coefficient	1 sigma uncertainty	Velocity error contribution at SECO +20 seconds			Coefficient (Fit 1)	Velocity error contribution at SECO +20 seconds			Coefficient (Fit 2)	Velocity error at SECO +20 seconds		
				$\Delta\dot{X}$ (ft/sec)	$\Delta\dot{Y}$ (ft/sec)	$\Delta\dot{Z}$ (ft/sec)		$\Delta\dot{X}$ (ft/sec)	$\Delta\dot{Y}$ (ft/sec)	$\Delta\dot{Z}$ (ft/sec)		$\Delta\dot{X}$ (ft/sec)	$\Delta\dot{Y}$ (ft/sec)	$\Delta\dot{Z}$ (ft/sec)
I Accelerometer														
X accelerometer bias	ppm g	46.6	10	0.22	-1.15		50	0.2	-1.3		N			
Y accelerometer bias	ppm g	0	10				N				N			
Z accelerometer bias	ppm g	76.9	10		0.89		80		0.9		80		0.9	
X accelerometer scale factor	ppm	-46	114	-1.15			-50	-1.2			N			
Z accelerometer scale factor	ppm	-451	66		3.06		-400		2.7		-300		2.0	
X accelerometer misalignment toward Z	sec	-14	33	0.46			N							
Z accelerometer misalignment toward X	sec	+2.5	39		0.30		-17.5		-2.1		90		10.8	
II Pitch Drift														
Y gyro constant drift rate	°/hr	+0.35	0.16	0.31	9.32		N				N			
Y gyro input axis unbalance	°/hr/g	-0.044	0.08	-0.15	-1.21		+0.56	1.9	15.3		N			
Y gyro spin axis unbalance	°/hr/g	+0.011	0.20		0.01		N				N			
III Roll and Azimuth Drift														
X gyro constant drift rate	°/hr	-0.013	0.19			0.13	N				N			
X gyro input axis unbalance	°/hr/g	-0.41	0.12	0.06	0.06	5.04	N				N			
X gyro spin axis unbalance	°/hr/g	+0.14	0.14	-0.01	0.03	-1.28	N				N			
Z gyro constant drift rate	°/hr	+0.20	0.13	-0.03		2.78	N				N			
Z gyro input axis unbalance	°/hr/g	-0.038	0.074	0.01		-1.34	+0.10			3.40	0.10			3.4
Z gyro spin axis unbalance	°/hr/g	-0.066	0.093			0.50	N				N			
IV System														
Platform misalignment about X accelerometer axis	sec	36	13	-0.05	-0.04	-3.90	N				N			
Platform misalignment about Y accelerometer axis	sec	17	31	0.56	2.04		N				N			
Platform azimuth misalignment	sec	19.8	10	0.06		2.37	+20			2.4	+20			2.4
IGS time correlation	sec	0.0546	10				+0.0556	0	0	0	0.0556	0	0	0
IGS time scale factor	ppm	-84.9	65				-92	0	0	0	-92	0	0	0
TOTAL				0.29	13.31	4.30		0.6	15.3	5.8		0	13.7	5.8

*N represents negligible coefficient.

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Table 2-9. TRW Proposed Error Model

Symbol	Error source	Units	1σ a priori uncertainty
*VOZ	Z accelerometer initialization	ft/sec	0.2
DT	Time correlation	sec	0.01
TSF	Time scale factor	ppm	20
*BX	X accelerometer bias	ppm g	10
*BY	Y accelerometer bias	ppm g	10
*BZ	Z accelerometer bias	ppm g	10
XSF	X accelerometer scale factor	ppm	160
ZSF	Z accelerometer scale factor	ppm	160
POX	Position bias - X computer axis	ft	50
POY	Position bias - Y computer axis	ft	50
POZ	Position bias - Z computer axis	ft	50
XZMSL	X accelerometer misaligned toward Z	arc sec	50
ZXMSL	Z accelerometer misaligned toward X	arc sec	50
XGCDR	X gyro constant drift rate	°/hr	0.2
YGCDR	Y gyro constant drift rate	°/hr	0.2
ZGCDR	Z gyro constant drift rate	°/hr	0.2
XGSAU	X gyro spin axis unbalance	°/hr/g	0.2
YGSAU	Y gyro spin axis unbalance	°/hr/g	0.2
ZGSAU	Z gyro spin axis unbalance	°/hr/g	0.2
XGIAU	X gyro input axis unbalance	°/hr/g	0.2
YGIAU	Y gyro input axis unbalance	°/hr/g	0.2
ZGIAU	Z gyro input axis unbalance	°/hr/g	0.2
PHIX	Platform alignment about X accelerometer axis	arc sec	50
PHIY	Platform alignment about Y accelerometer axis	arc sec	50
PHIZ	IGS azimuth alignment	arc sec	10
A4(1)	MISTRAM I refraction - central site	n-units	2.0
CO(3)	GE MOD III range bias	ft	10

*Not solved for in regression. (See Subsection 2.2.3.)

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Table 2-9. TRW Proposed Error Model (Concluded)

Symbol	Error source	Units	1σ a priori uncertainty
C2(3)	GE MOD III timing	sec	0.001
C4(3)	GE MOD III refraction	n-units	2.0
C5(3)	GE MOD III survey (east)	ft	3.0
C6(3)	GE MOD III survey (north)	ft	3.0
C7(3)	GE MOD III survey (up)	ft	1.0
DO(3)	GE MOD III azimuth bias	millirad	0.2
FO(3)	GE MOD III elevation bias	millirad	0.2

The results of the final regression solution have been presented in part in Table 2-8. Also recovered were the following tracking system and IGS position bias errors along with their one sigma uncertainties.

MISTRAM I refraction = -0.48 ± 2.0 n-units

GE MOD III range bias = -23 ± 3.8 ft

GE MOD III timing bias = -0.61 ± 0.22 millisec

GE MOD III refraction = -4.44 ± 2.22 n-units

GE MOD III azimuth bias = -2.7 ± 15 μrad

GE MOD III elevation bias = +44 ± 11 μrad

X computer axis position bias = -3.9 ± 4.0 ft

Y computer axis position bias = +20.2 ± 5.2 ft

Z computer axis position bias = -19.6 ± 7.8 ft

IGS data position bias errors are considered to result from postflight data reduction errors rather than the IMU. The effect of tracking data errors on IGS/tracking data comparisons is discussed in Section 4.

The ability of the regression to fit the residuals is graphically displayed by heavy lines drawn upon the tracker coordinate position and velocity residuals in Figures 2-10 through 2-13. These lines represent the total error contribution of the recovered coefficients. It can be seen that the residuals between the lines and the respective data points are for

the most part unbiased and the indicated line closely approximates the apparent position and velocity errors.

The degree to which the recovered IMU error sources explain the IGS/tracker residuals in guidance coordinates is indicated in Figure 2-9 by a heavy line. The x-axis residuals are explained by the IMU functions to within the data noise; however, unexplained residuals remain in the y and z axes. These residual differences are attributed to a MISTRAM P_{100K} bias of -0.5 ft and a GE MOD III refraction error of -4.4 n-units. On the other hand, the IMU functions accounted for nearly all of the IGS/MISTRAM 10K residuals suggesting that the MISTRAM 10K bias errors were smaller than those of the 100K data (see Figures 4-3 and 4-4 of Section 4).

Recovery of the MISTRAM I position bias errors was accomplished by compensating the IMU/tracker position domain residuals with the errors recovered in the regression analysis and estimating the bias levels from the remaining position errors (Section 4).

2.3 IGS AZIMUTH UPDATE

The IGS azimuth alignment update corrections were successfully accomplished on this flight. The initial alignment correction was obtained, during the first pass through the navigation equations, by comparing the actual platform roll gimbal angle after platform release with the desired value. Additional azimuth corrections were made at 100 and 140 seconds after liftoff. These were 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 about the vertical axis.

Table 2-10 compares the initial IGS alignment correction, total inflight update obtained, and residual alignment error on Gemini 10 with those obtained on previous Gemini missions. This summary shows that the Gemini 10 corrections are consistent with those obtained on previous flights. The residual azimuth misalignment on this flight was considerably smaller than rendezvous flights 6, 8, and 9.

Table 2-10. History of Azimuth Alignment Correction

Flight No.	Initial alignment correction (deg)	Inflight update (deg)	Total Alignment Correction (deg)	Residual azimuth error (arc sec)
2	-0.07	-0.22	-0.29	0
3	+0.01	-0.53	-0.52	0
4	+0.03	-0.15	-0.12	0
5	+0.05	-0.32	-0.27	0
6	+0.06	-0.59	-0.53	-40
7	-0.01	-0.47	-0.48	0
8	+0.11	-0.21	-0.10	+57
9	+0.17	-0.40*	-0.23*	+48
10	-0.09	-0.13	-0.22	+20
Mean	+0.03	-0.34	-0.31	
		NASA/Honeywell Specification	0.75	

* Simulated

2.4 CONCLUSIONS

a) The IGS vertical (y) velocity error of over 13 ft/sec was larger than expected. Error in the x and z coordinates was nominal.

b) The net effect of the inflight gyro compensation was to increase the IGS y coordinate error by 4 ft/sec and leave the z coordinate error magnitude unchanged. However, the compensation would have significantly reduced (5 ft/sec) the z coordinate error magnitude if the Burroughs' azimuth update correction had been accurate. Available preflight gyro calibration data indicate that a logical set of preflight compensation coefficients was selected.

c) A very large IGS time correlation error of 0.055 seconds was observed; however, the major portion, 0.049 seconds, is attributable to a known TRS bias. The clock drift of 85 parts per million was also large, but is consistent with that observed on previous flights.

d) Inflight updating of the IGS azimuth alignment was successfully accomplished, though a residual azimuth error equivalent to 20 sec remained after updating. The residual error is one-half or less than that observed on any other rendezvous flight.

e) Accelerometer bias errors recovered on this flight were nominal though apparent shifts occurred between ascent and reentry.

2.5 ASCENT TRAJECTORY RECONSTRUCTION

The ascent trajectory reconstruction consists of IGS data corrected for the alignment errors and IMU error sources presented in Table 2-8. A listing of this reference trajectory is provided in Appendix A.

The trajectory is given in an earth-centered inertial coordinate system. The z axis is aligned with the earth's rotational axis, positive north, and the x-y plane is the equatorial plane with the x-z plane containing the Greenwich meridian at platform release time. The time is referenced to liftoff, 3.260 seconds after platform release. Trajectory parameters such as velocity magnitude, altitude, flight path angle, heading, latitude and longitude are also printed.

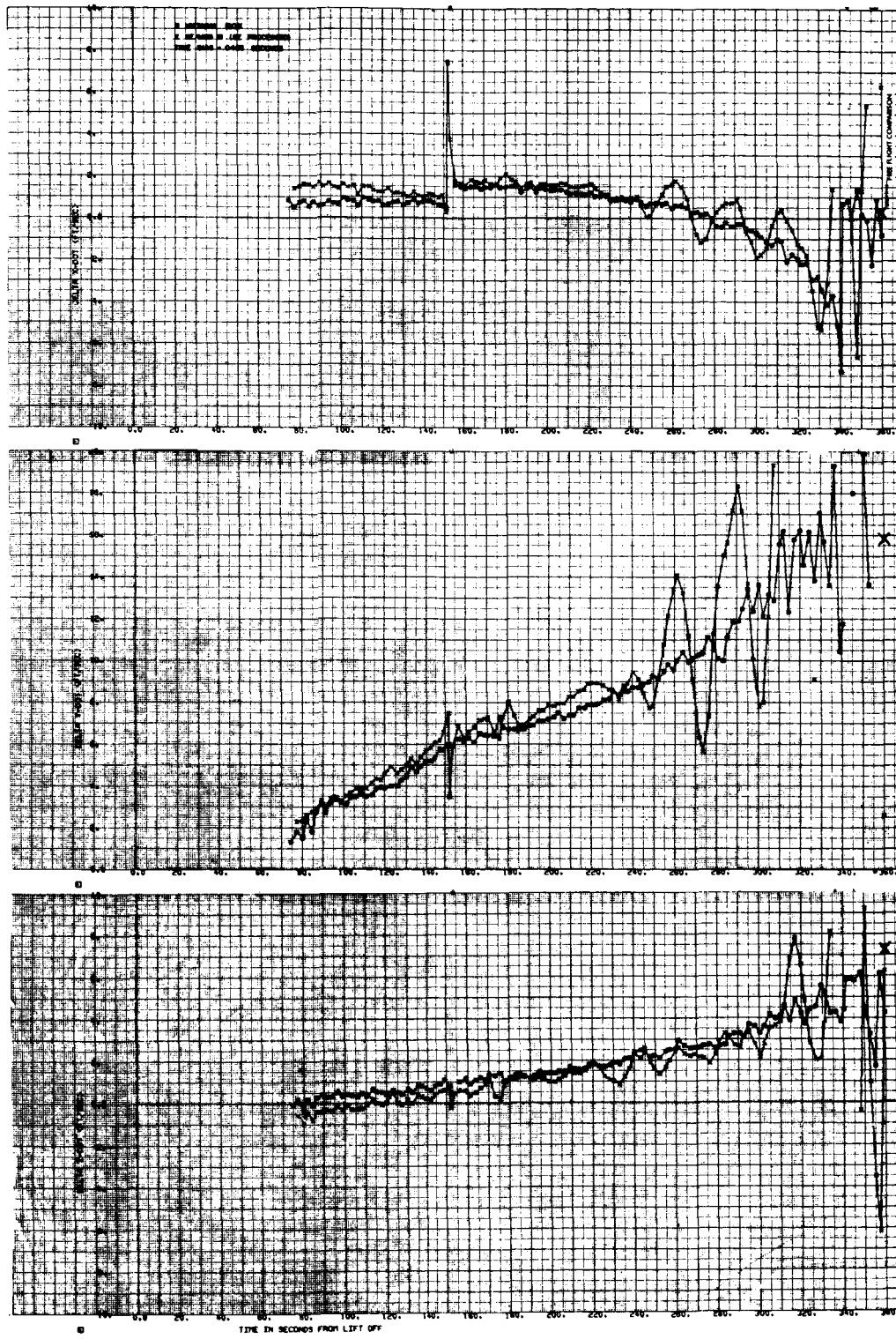

Figure 2-1. Sensed Velocity Comparison in Computer Coordinates

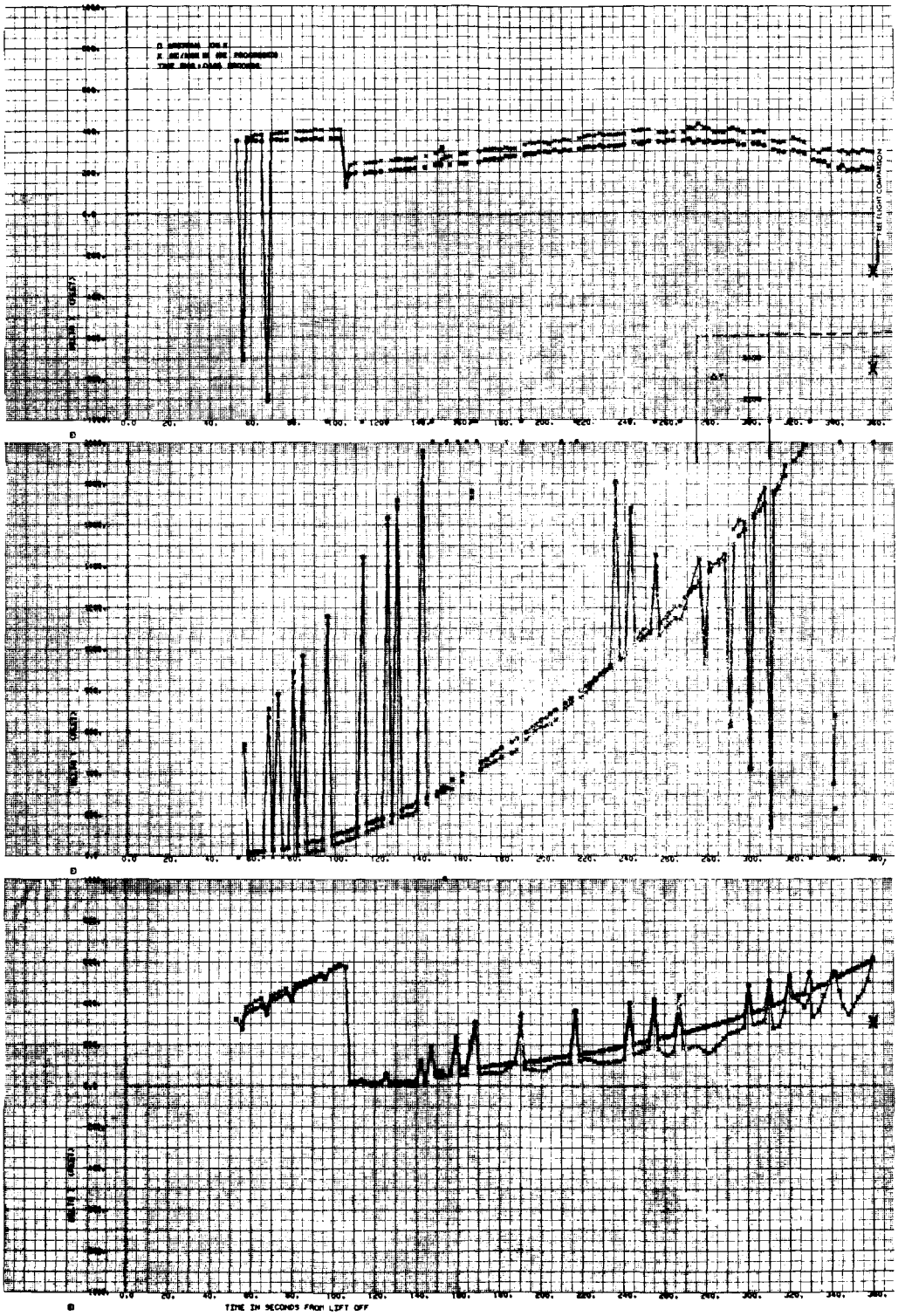

Figure 2-2. Total Inertial Position Comparison in Computer Coordinates

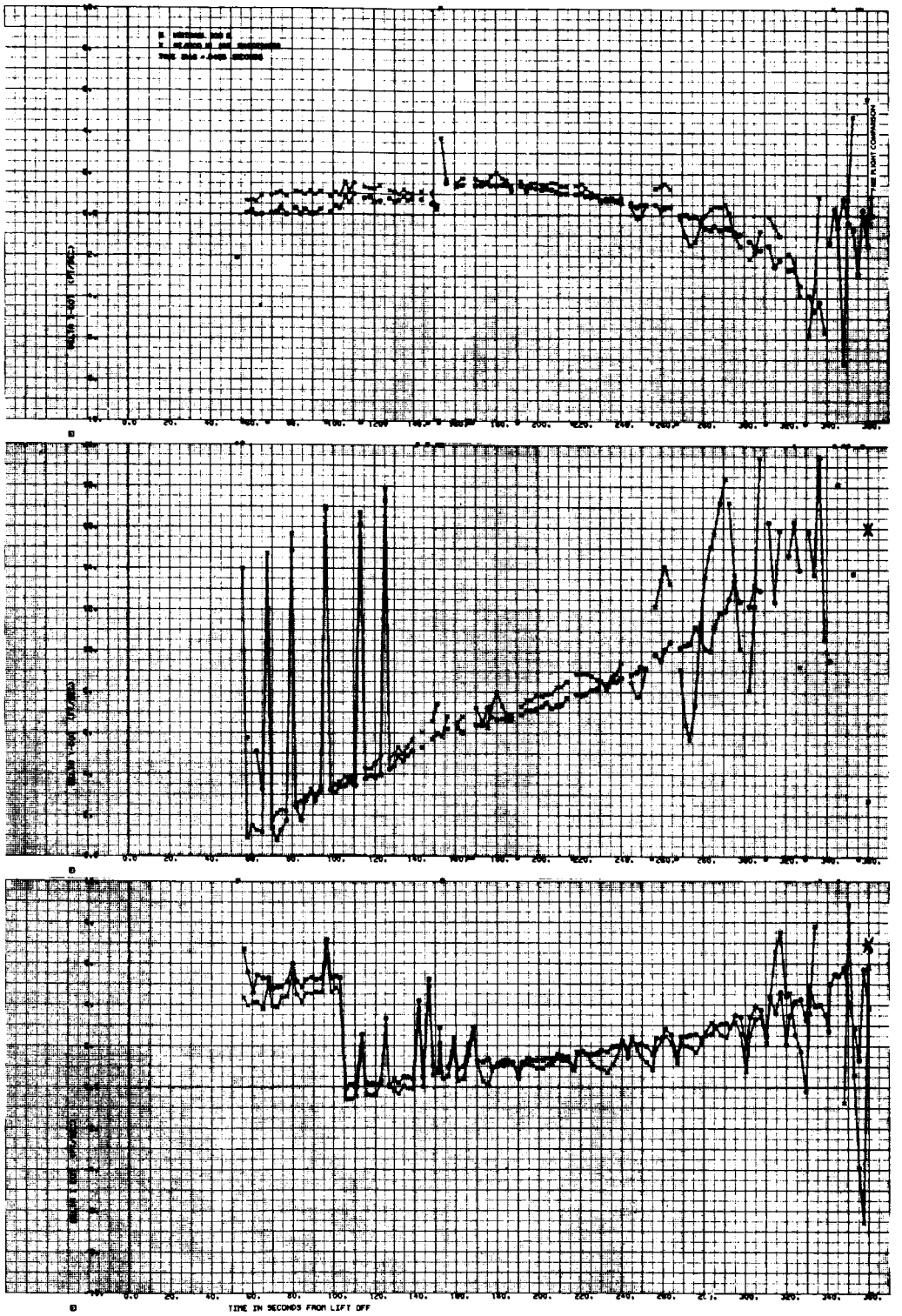

Figure 2-3. Total Inertial Velocity Comparison in Computer Coordinates

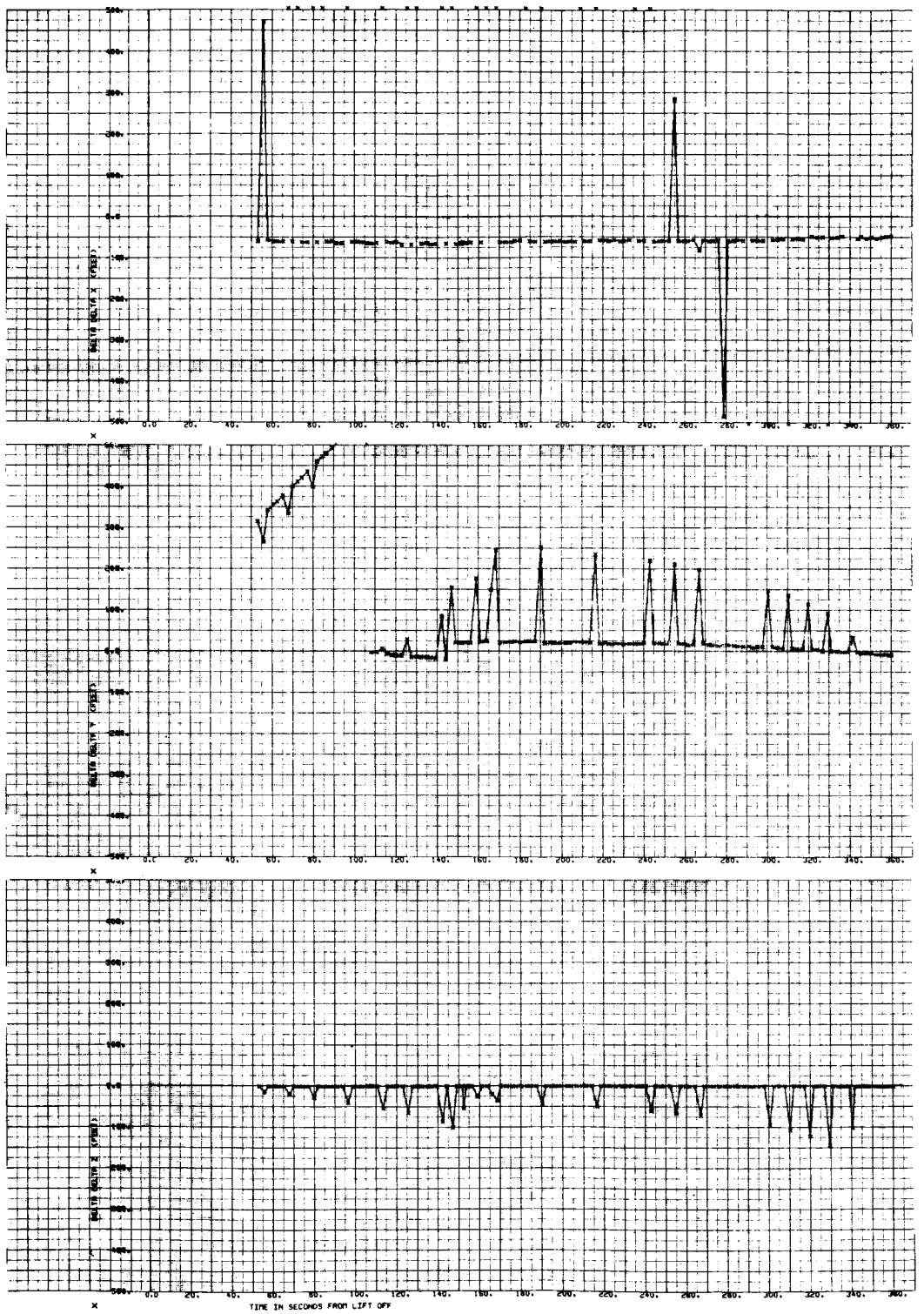

Figure 2-4. Navigation Position Error

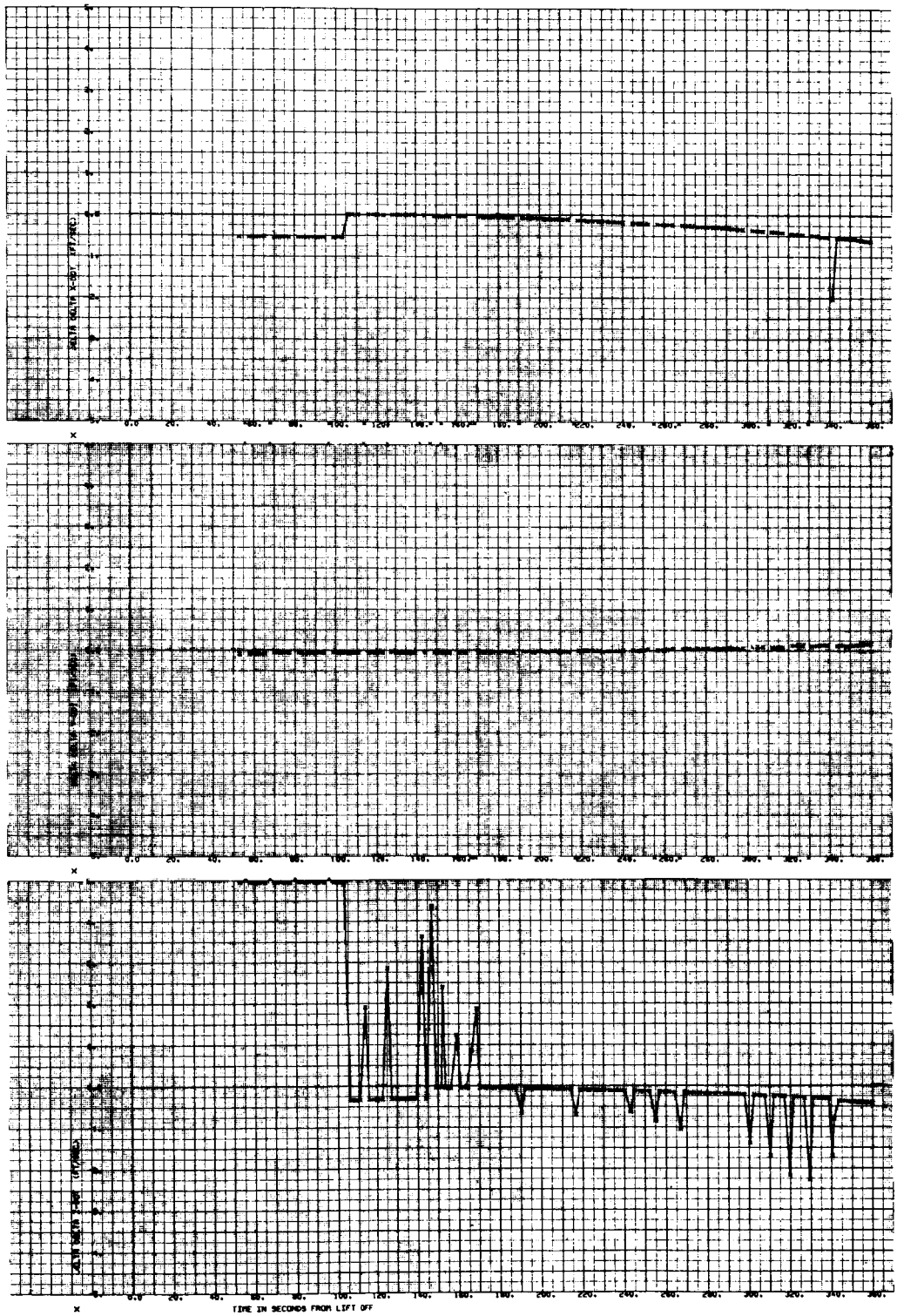

Figure 2-5. Navigation Velocity Error

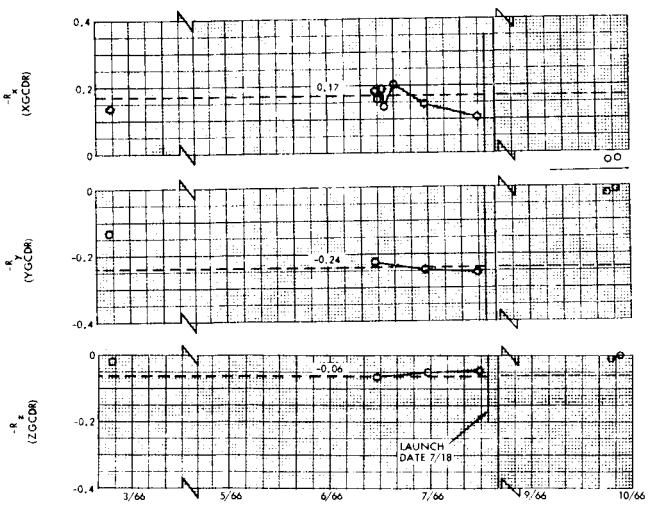

Figure 2-6. Gyro Constant Drift Rate History

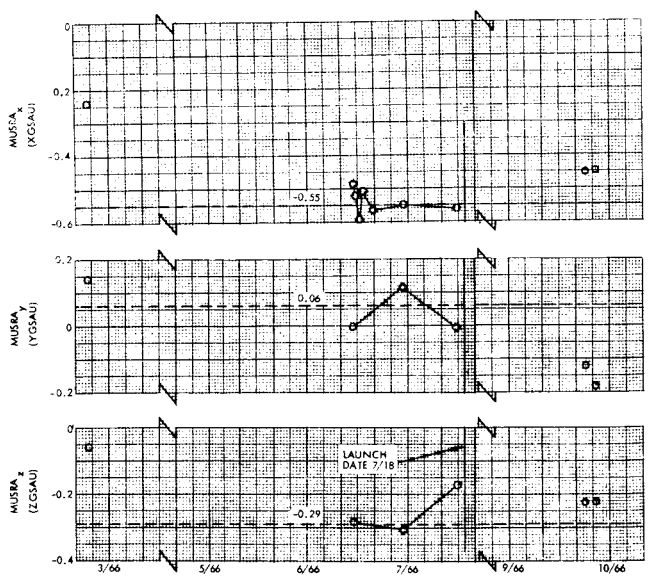

Figure 2-7. Gyro Spin Axis Unbalance Drift History

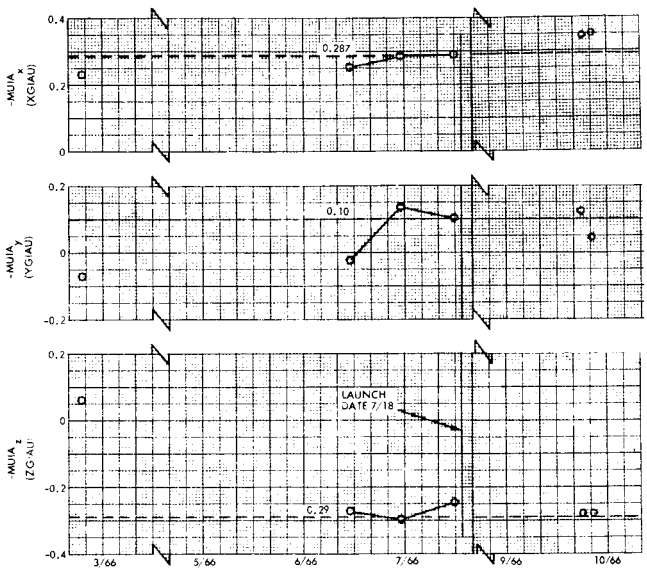

Figure 2-8. Gyro Input Axis Unbalance Drift History

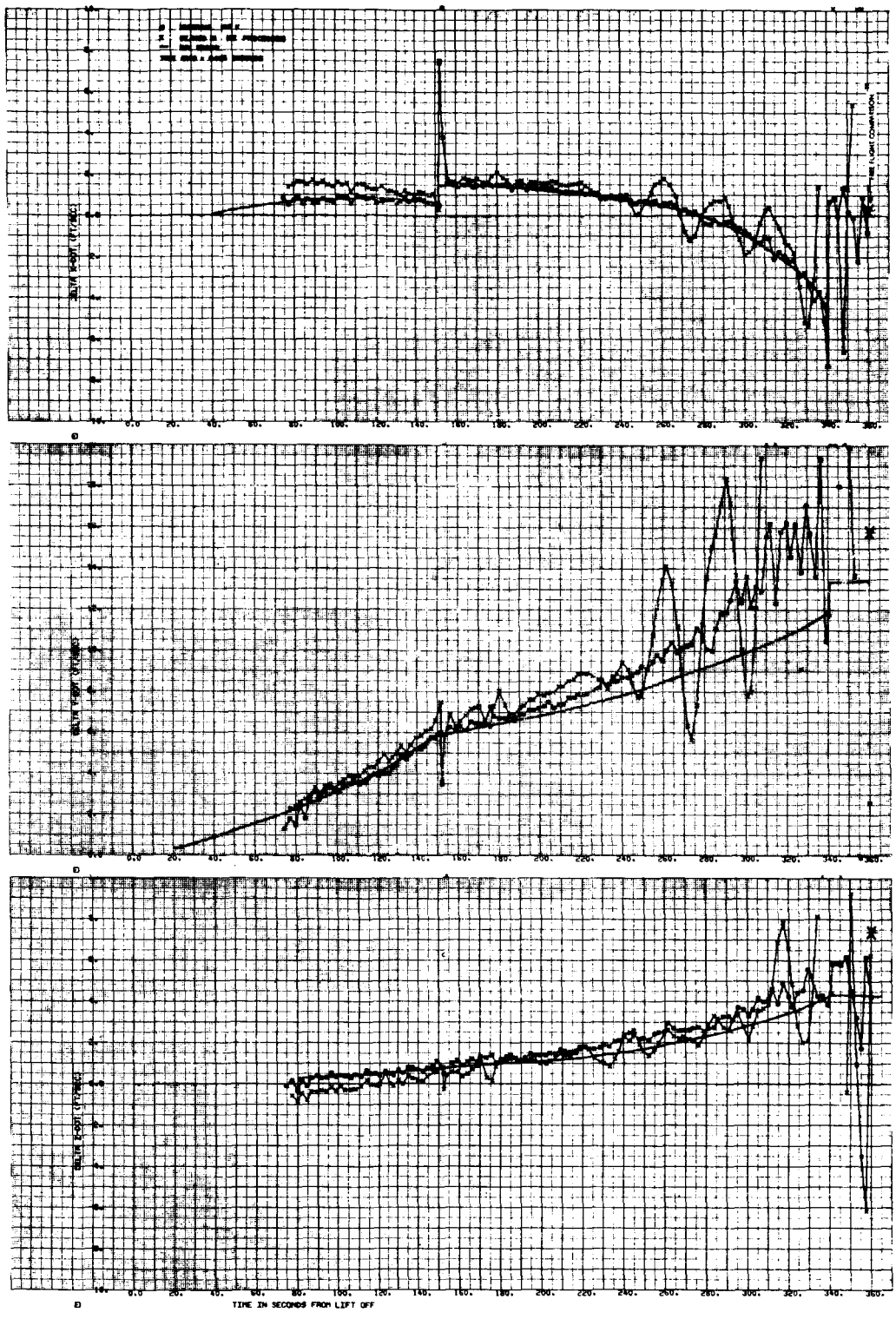

Figure 2-9. Sensed Velocity Comparison in Computer Coordinates with IGS Error Fit

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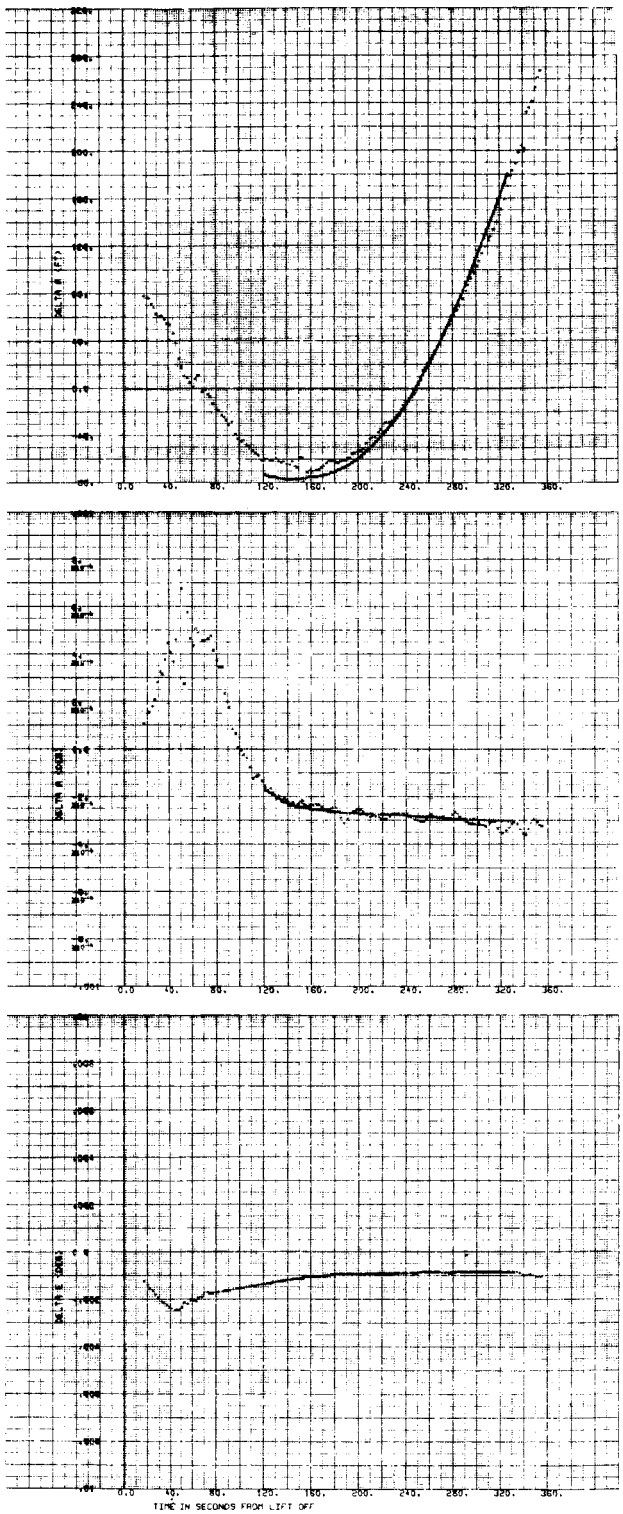

Figure 2-10. IGS/Mod III Comparisons (RAE)

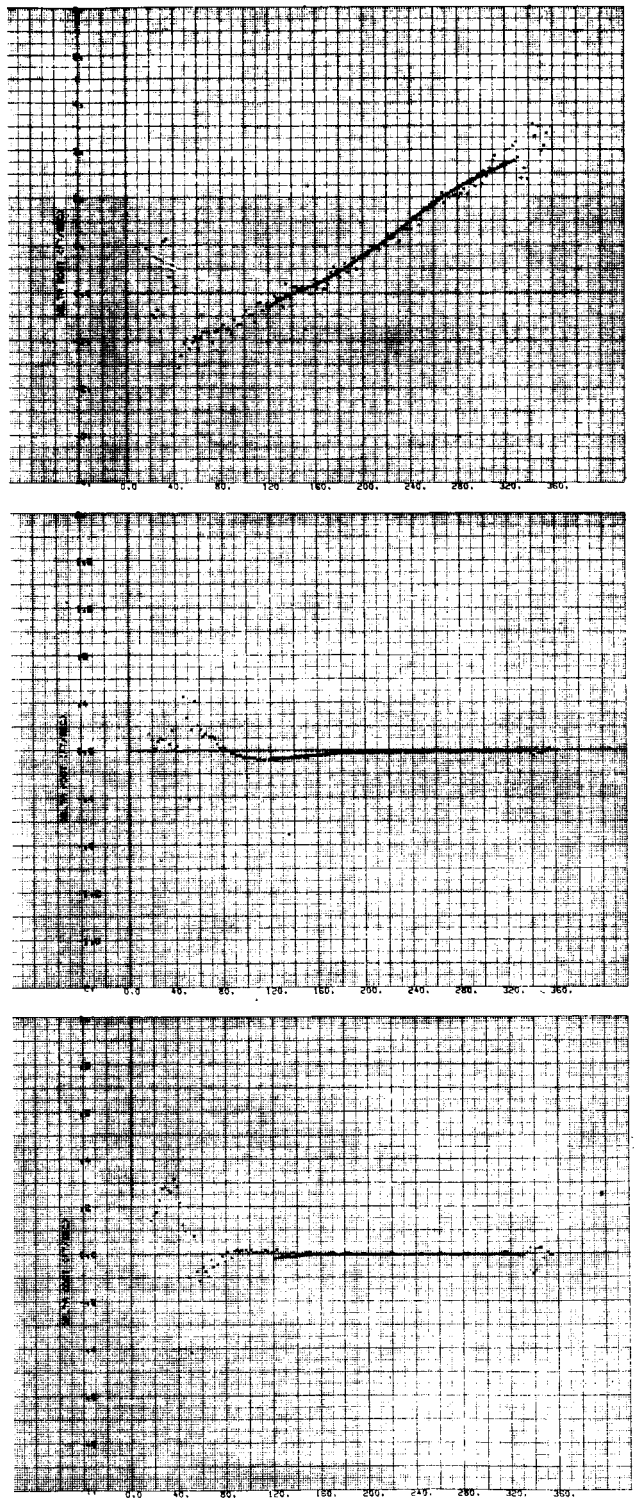

Figure 2-11. IGS/Mod III Comparisons (Range Rate, $\dot{R}$, $\dot{P}$, and $\dot{Q}$)

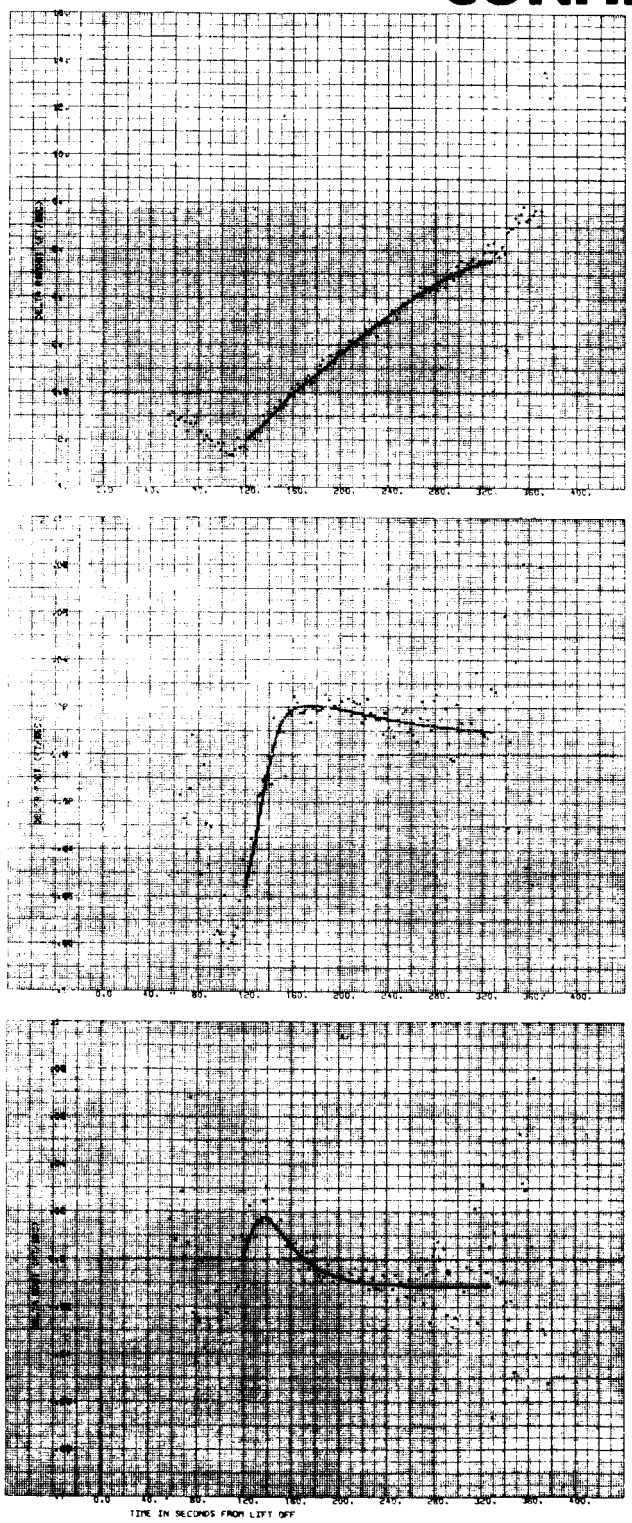

Figure 2-12. IGS/MISTRAN I, 10K Comparisons (Range Rate, $\dot{R}$, $\dot{P}$, and $\dot{Q}$)

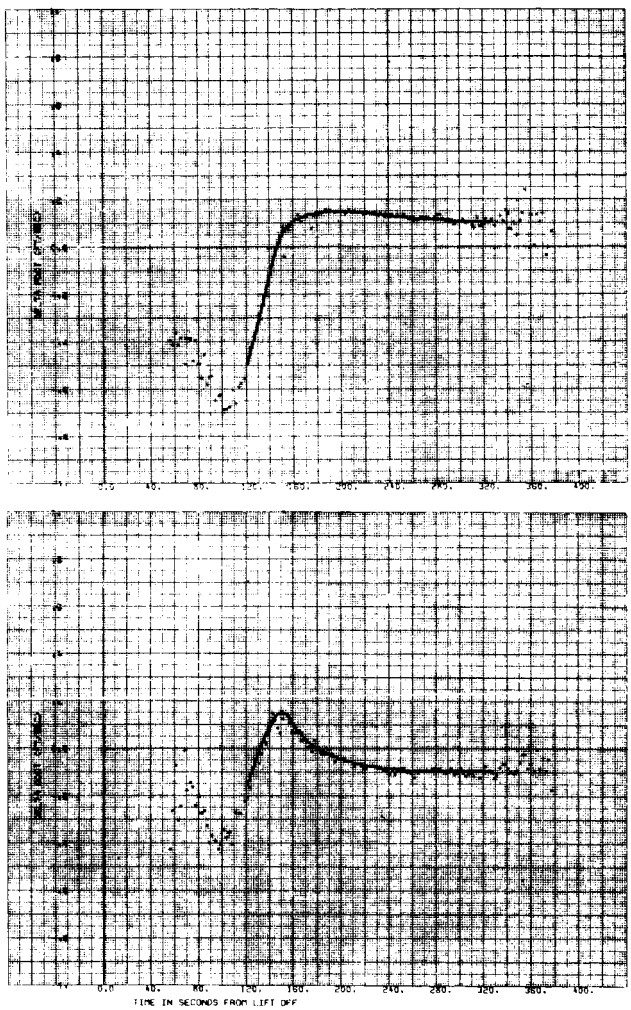

Figure 2-13. IGS/MISTRAM I, 100K Comparisons (Range Rate, $\dot{P}$ and $\dot{Q}$)

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3. REENTRY IGS PERFORMANCE EVALUATION AND TRAJECTORY RECONSTRUCTION

3.1 INTRODUCTION AND SUMMARY

This section presents an evaluation of the IGS performance during the reentry flight phase. The evaluation was accomplished by comparing telemetered IGS quantities with external tracking data and with nominal terminal phase conditions, and estimating the most likely error sources from the residual trends.

The following C-band radar and telemetry were available for the analysis:

Data Source	Interval (sec from retrofire)
19:18, Merritt Isl.	1550 to 1747
0:18, Patrick AFB	1550 to 1750
3:18, Grand Bahama Isl.	1558 to 1757
7:18, Grand Turk Isl.	1721 to 1815
PCM Telemetry	0 to 2062

Table 3-1 provides various estimates of the spacecraft location at the times of significant events during the latter part of reentry. This same information is graphically displayed in Figure 3-1 along with the ground trace of the spacecraft as given by a TRW reconstruction of the spacecraft trajectory, uncorrected IGS data, and the last part of Grand Turk radar tracking. Table 3-2 summarizes the TRW estimate of guidance and control error on this flight. It is noted that very little of the indicated downrange miss can be attributed to IGS measurement error. The crossrange miss may be partially explained by the indicated IGS error. If the IGS is in error to the south, it would be expected that the spacecraft would be steered to the north of the intended target.

3.2 REENTRY ERROR SOURCES

Table 3-3 presents a summary of recovered error sources which provide an explanation for the apparent IGS error at guidance termination. To extract error sources from the available data the telemetered IGS trajectory was reconstructed using the RTCC retrofire position/velocity

[redacted]

Table 3-1. Gemini 10 Reentry Trajectory Summary

Source of Data	Altitude (1000 ft)	Latitude (deg N)	Longitude (deg W)	Difference from target (n mi)	
				North	East
Guidance Termination (t* = 1815)					
IGS (uncorrected)	56	26.682	71.992	-2.0	0.43
TRW BET	76	26.764	71.986	2.9	0.75
Drogue Deployment (t* = 1870)					
TRW BET	37	26.768	71.902	3.2	5.2
IGS**	2	26.633	71.915	-4.9	4.6
Main Chute Deployment (t* = 1951)					
TRW BET	7	26.764	71.894	2.9	5.7
IGS**	-50	26.558	71.940	-9.4	2.3
Splashdown					
Target	0	26.715	72.00	0	0
Ship measurement	0	26.745	71.95	1.8	2.7
TRW BET (final telemetry point, t* = 2062)	2	26.756	71.888	2.5	6.0
IGS (final telemetry point)**	-90	26.456	71.991	-16.0	0.5

*Time from retrofire in seconds.
**Differences between the IGS and true trajectories at times after "guidance termination" do not affect trajectory accuracy, but are useful for identification of error sources.

Table 3-2. Reentry Error Summary

Direction of error*	Value of IGS error at guidance termination (76,000 ft) (n mi)	Spacecraft miss distance from intended target at impact (n mi)
Downrange	0 ± 0.3	5.1 ± 0.5 (long)
Crossrange	-4.9 ± 0.3 (south)	2.9 ± 0.5 (north)
Vertical	-3.3 ± 0.3 (low)	

*Downrange/crossrange error estimates are based on an approach azimuth of 94° from North.

[redacted]

Table 3-3. Effects of Error at Guidance Termination (76,000 Feet) in IGS Coordinates

Error source	Unit	Coefficient	X (ft)	Y (ft)	Z (ft)	$\dot{X}$ (ft/sec)	$\dot{Y}$ (ft/sec)	$\dot{Z}$ (ft/sec)
X accelerometer bias	μg	6.23 ± 10	317			0.2		
Y accelerometer bias	μg	43.58 ± 10			-2,221			-1.7
Z accelerometer bias	μg	46.69 ± 10		2,469			2.7	
Platform roll alignment	arc sec	-2,337 ± 150		56	-21,683		-1.0	-226.5
Platform pitch alignment	arc sec	-2,000 ± 300	-18,556	-5,902		-199	-117	
Platform yaw alignment	arc sec	-1,565 ± 150	-37		-4,618	0.7		-91.7
Y gyro input axis unbalance	°/hr/g	-0.715 ± 0.4	-1,422	-855		-21.5	-14.9	
Timing scale factor	ppm	-86 ± 65	-1,832	2,952	-14	-9.4	6.6	0.2
X accelerometer scale factor	ppm	-46 ± 113	33			-0.64		
Z accelerometer scale factor	ppm	-451 ± 64		876			9.2	
Initial conditions	ft, ft/sec	(See table 3-4)	-280	1,200	290	-0.9	-0.8	1.3
Unexplained position	ft		1,500	2,000	2,000			
		Total	-20,300	2,800	26,200	-230.0	-115.0	-318.0

(state) vector, the telemetered time from retrofire, and properly scaled and biased accelerometer count data. The reconstructed IGS trajectory was then compared to the radar-determined trajectory (see Figure 3-2). A visual analysis was made in which probable error sources were combined to provide an explanation for the observed IGS/radar residuals.

In addition to providing an explanation (or fit) of the IGS radar residuals, the recovered error sources were constrained to provide explanations for differences between the IGS and nominal estimates of spacecraft main chute deployment altitude, descent rate, and available wind velocity data. The altitude rate was fit to approximately 30 feet per second during main chute descent. However, analysis showed that the drogue chute altitude could not be fit to an assumed 50,000-foot nominal value. After removal of the drogue altitude constraint, the analysis showed an estimate for the actual drogue chute deployment to be 37,000 feet (which was later substantiated by NASA's determination of a 38,000-foot drogue altitude).

The following sections provide discussions of the recovered reentry error sources listed in Table 3-3.

3.2.1 Initial Conditions

Reentry initial conditions input into the IGS were computed by the real time computer complex (RTCC), using the Carnarvon, Revolution 42 update, approximately one orbit prior to retrofire. The RTCC initial position/velocity vector is presented in Table 3-4 and compared with TRW estimates of the retrofire position/velocity vector. The TRW vector was derived from the postflight orbit reconstruction program (ESPOD) by fitting pre-retrofire and post-retrofire free flight tracking data while including a solution for the retrofire maneuver.

The agreement between the RTCC and TRW (ESPOD) vectors is well within 1000 feet and 1 foot/second, and is considerably smaller than has been noted on previous flights.

It is interesting to investigate the ESPOD solution for the retrofire maneuver. Table 3-5 gives the indicated IGS retrofire maneuver and small additional impulse apparently resulting from the retrosection

Table 3-4. Gemini 10 Reentry Retrofire Vector Summary
(21 July $20^h30^m51.0^s$ GMT)

[Coordinates are those used in the MSC RTCC - ECI, X through Greenwich at 0 hours day of launch (18 July).]

Vector	IGS (RTCC)	TRW (ESPOD)	RTCC - TRW
X (ft)	-13,815,300	-13,814,853	-447
Y (ft)	17,301,300	17,302,284	-984
Z (ft)	-746,400	-747,096	+696
$\dot{X}$ (ft/sec)	-17,381.1	-17,380.9	-0.2
$\dot{Y}$ (ft/sec)	-13,556.7	-13,555.9	-0.8
$\dot{Z}$ (ft/sec)	12,137.7	12,137.7	0

Table 3-5. Retrofire Maneuver Summary

Impulse source	$\Delta\dot{x}$ (ft/sec)	$\Delta\dot{y}$ (ft/sec)	$\Delta\dot{z}$ (ft/sec)
IGS indicated retrofire	-303.0	118.7	-5.0
Retro jettison	-0.3	0.3	0
Total indicated impulse	-303.3	119.0	-5.0
IGS misalignment error	1.1	2.9	3.6
Corrected retrofire impulse	-304.4	116.1	-8.6
ESPOD (free flight reconstruction)	-304.5	117.4	-9.7

jettison (retrofire plus 55 seconds) as obtained from telemetered IGS data (see sensed velocity plots Figure 3-4). Subtracted from the indicated maneuver is the net error in the IGS measurement resulting from the estimated platform misalignment. The ESPOD reconstruction value can then be compared with this adjusted IGS value. The agreement is very good and within the uncertainty generally associated with the trajectory reconstruction. The IGS platform misalignment errors were deduced from atmospheric IGS/tracking comparisons and terminal position/velocity criteria as described in paragraph 3.2.2. Large changes

would be required in the IGS misalignment error estimates during atmospheric reentry to significantly change the indicated IGS retrofire measurement error shown in Table 3-5. This comparison, therefore, supports the validity of the ESPOD maneuver solution.

3.2.2 Alignment Errors

The primary assumption in attempting to extract IGS error sources during reentry was that platform alignment errors were most likely the dominant sources. Using this guideline, a set of alignment errors were determined which removed the error trend indicated in the IGS/tracker position comparisons of Figure 3-2. (Analysis could not be conducted in the velocity domain because of the very high noise on the differentiated radar position measurements.) Some tradeoff with gyro-drift type errors was required to satisfy both the radar tracking data and expected terminal phase conditions.

The platform alignment error coefficients recovered are consistent with those recovered on previous flights and provide an explanation for the major portion of the IGS trajectory error. This is evident in Table 3-3 which shows that the contributions of the misalignment errors are within 17 and 20 percent of total IGS trajectory x and z position errors respectively. The y axis contribution, although also large, had an approximate magnitude equal to the combination of all other contributors, but was in the opposite direction such that the total y error was quite small.

3.2.3 IGS Error Sources

The accelerometer bias errors listed in Table 3-3 were obtained from post retrofire IGS accelerometer output during free-flight. The X and Z accelerometer and timing scale factor errors were recovered during the ascent IGS analysis, as described in Section 2. These were included in the corrections to the IGS indicated reentry trajectory; however, the accelerometer scale factor errors do not contribute significantly to the fit.

The pitch gyro drift error was recovered after initial attempts to explain IGS/tracker differences with only platform alignment errors successfully nulled the IGS/radar differences, but a trajectory was produced which went down to a 20,000-foot altitude and then began

climbing again. A more satisfactory trajectory resulted when the Y gyro input axis unbalance term (YGIAU) was substituted for part of the misalignment error used in the original fit. The position error propagations during reentry of a Y gyro input axis unbalance error (YGIAU) and a pitch misalignment (PHIY) are shown in Figure 3-5. It is noted that though their propagation is similar during the interval of radar tracking (1550 to 1820 seconds), the gyro drift error grows much faster than the misalignment error during the terminal phase of flight (1870 seconds and [redacted]

The difference is undoubtedly due to a combination of error sources which were not identified in the analysis. Among these are:

a) Small error in the assumed (ESPOD) initial conditions. This source is particularly sensitive since it propagates for 1500 seconds before being "observed" in the reentry radar comparison data.

b) Incorrect selection of IGS error sources which, though they explain the very large error trends (over 25,000 feet and 200 feet/second), do not generate a completely consistent trajectory from retrofire to splashdown.

c) Inadequate error modeling to account for the error in the calculation of gravity resulting from the IGS errors.

d) Undiscovered systematic biases in the radar measurements.

Since the main goal of the analysis was to generate the most accurate trajectory reconstruction possible during atmospheric reentry, the apparent position bias was removed in the trajectory published here by arbitrarily altering ESPOD initial conditions as indicated below (ESPOD-BET).

$$\Delta x = 705 \text{ ft}$$
$$\Delta y = 600 \text{ ft}$$
$$\Delta z = 2104 \text{ ft}$$
$$\Delta \dot{x} = -0.8 \text{ ft/sec}$$
$$\Delta \dot{y} = 0.2 \text{ ft/sec}$$
$$\Delta \dot{z} = 3.7 \text{ ft/sec}$$

3.3 REENTRY SIMULATION

A six-degree of freedom simulation of the Gemini 10 reentry was conducted by McDonnell Aircraft. The simulation was initialized with the RTCC retrofire position/velocity vector which initialized the IGS, assumed preflight aerodynamic characteristics, and the best postflight estimate of the spacecraft center of gravity. Comparisons of the simulation results with the TRW BET (Figure 3-6) show residuals of -6300, 9083, and -9446 in the IGS x, y, and z axes, respectively, at 1400 seconds. Similar differences were noted between the simulation and a reconstruction of the post retrofire free-flight interval prior to atmospheric reentry derived from the orbit reconstruction program (ESPOD).

The available data were not sufficient for determination of the apparent simulation error which caused a large residual even before atmospheric reentry. However, the error could not have been due only to the initial vector, since the ESPOD and RTCC vectors were relatively close (see Table 3-4), but may be associated with the incorporation of the incorrect retrofire maneuver in the simulation.

During atmospheric reentry the error became an order of magnitude worse, since the computations probably used erroneous drag acceleration derived from simulation computed spacecraft altitude. The (simulation-BET) residuals steadily increased from the values at 1400 seconds to approximately 119,000, -222,000 and 29,000 feet in x, y and z at the last telemetry data point (t = 2062).

No comparison was made between the TRW reconstruction and the reentry trajectory presented in the MSC Final Report (Reference 6).

3.4 CONCLUSIONS

a) The IGS computed trajectory was approximately 3.9 n. mi. south and 0.36 n. mi. west of the actual trajectory at guidance termination. The actual trajectory was approximately 2.5 n. mi. north and 6.0 n. mi. east of the intended target at splashdown.

b) Approximately 80 percent of the apparent IGS error is attributable to platform alignment error of approximately 0.6 degree at retrofire.

c) MSC real-time (RTCC) and TRW postflight (ESPOD) estimates of the retrofire position/velocity vector were within expected tolerances. However, the final TRW BET indicates the possibility of cross-range (z) differences of approximately 3000 feet and 3.7 feet per second.

d) Large differences exist between a McDonnell simulated reentry trajectory and both the TRW reconstructions during the post-retrofire free-flight interval and the atmospheric reentry BET. The major source of the difference is in the simulation.

3.5 REENTRY TRAJECTORY RECONSTRUCTION

The reentry trajectory reconstruction consists of the IGS data corrected for initial conditions, initial platform misalignment, and IMU error sources as presented in Table 3-3. A listing of the BET is provided in Appendix B.

The data are provided in an earth-centered inertial coordinate system. The z axis is aligned with the earth's rotational axis, positive north, and the x-y plane is the equatorial plane with the x-z plane containing the Greenwich meridian at retrofire time. Trajectory parameters such as velocity magnitude, altitude, flight path angle, heading, latitude and longitude are also printed. Time is referenced to retrofire.

Figure 3-7 is a plot of reentry relative velocity, flight path angle, and altitude versus time from retrofire. The uncorrected sensed acceleration and velocity are plotted in Figure 3-8.

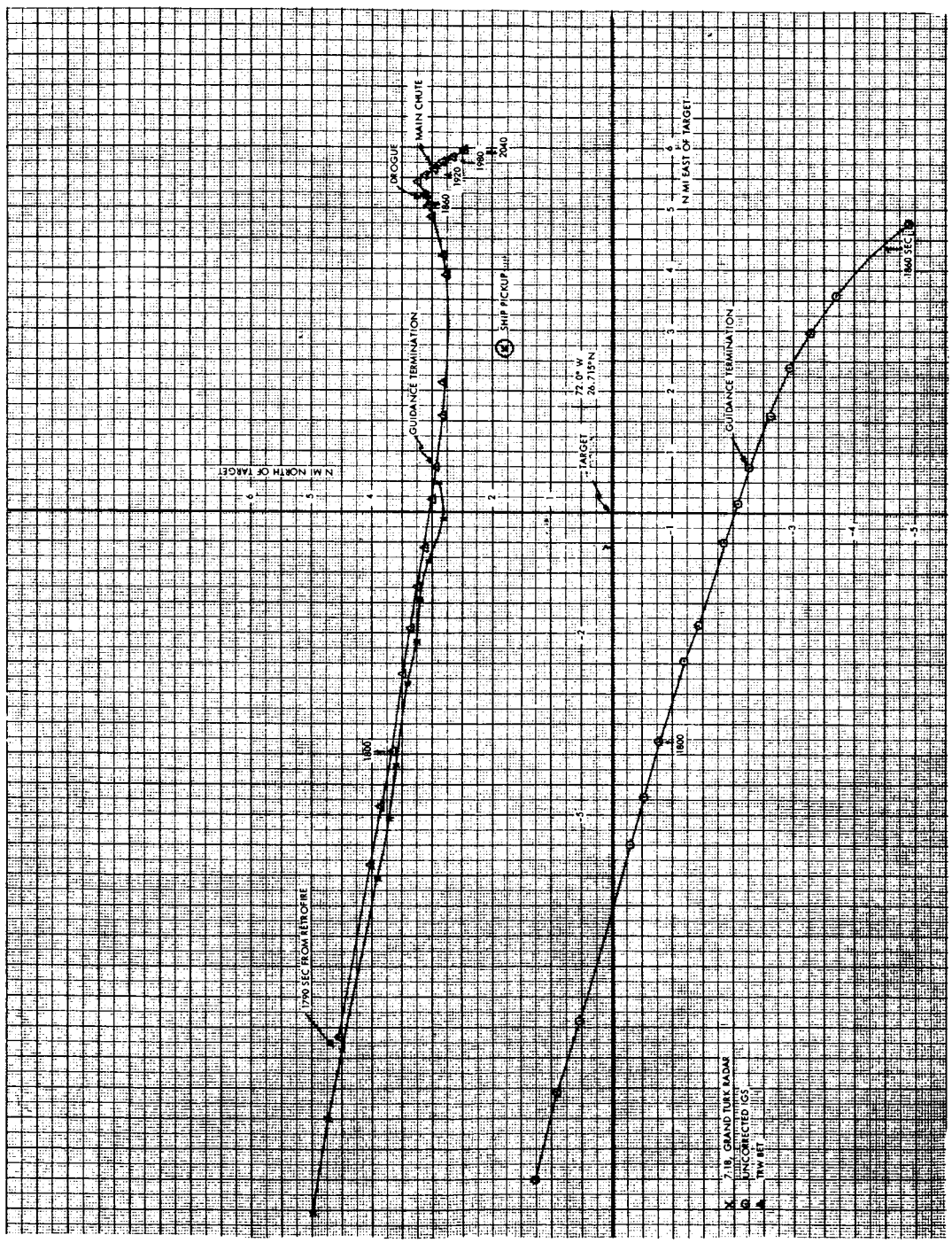


Figure 3-1. Gemini Reentry Ground Trace

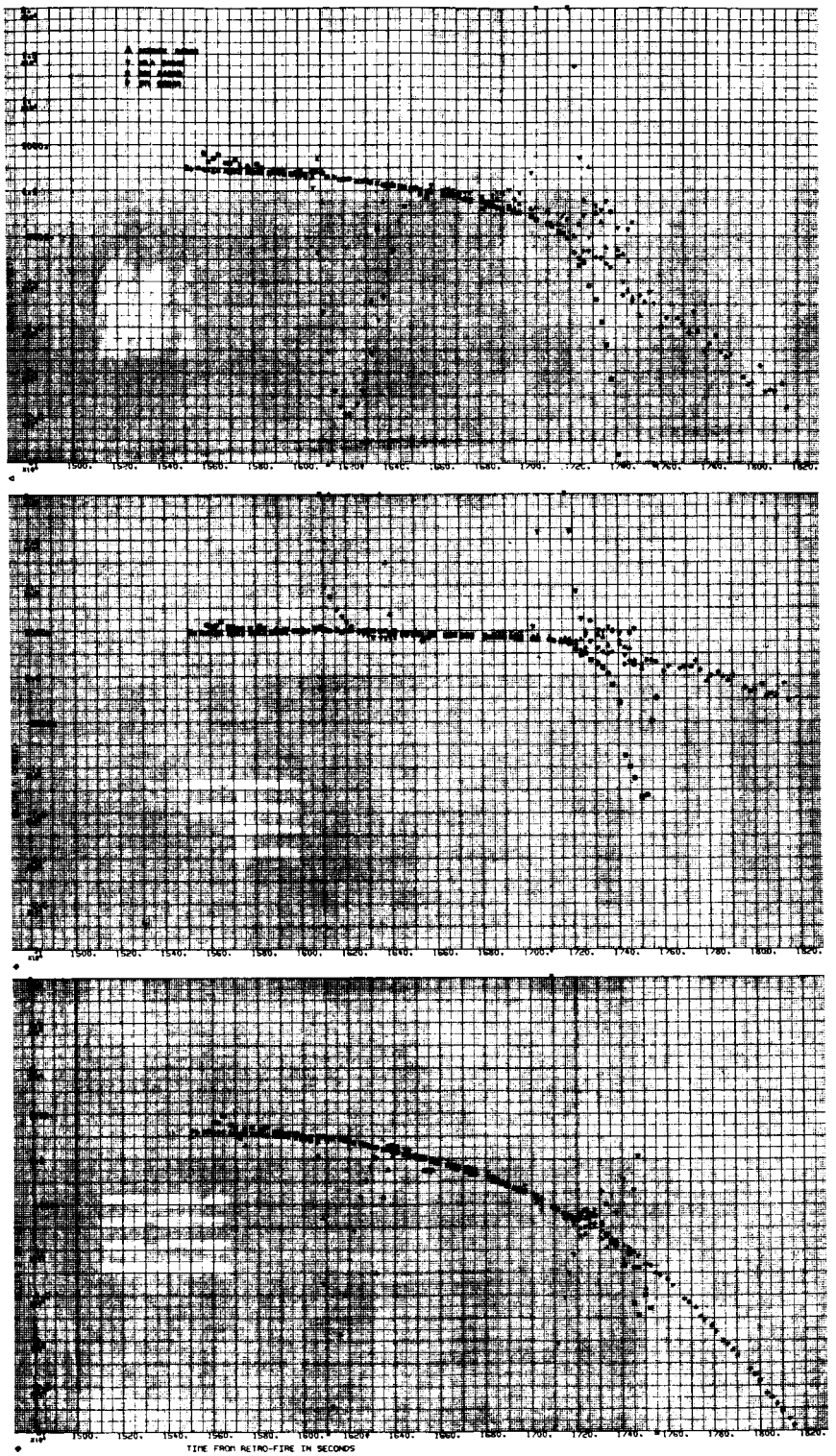


Figure 3-2. Uncorrected IGS - Radars in IGS Coordinates

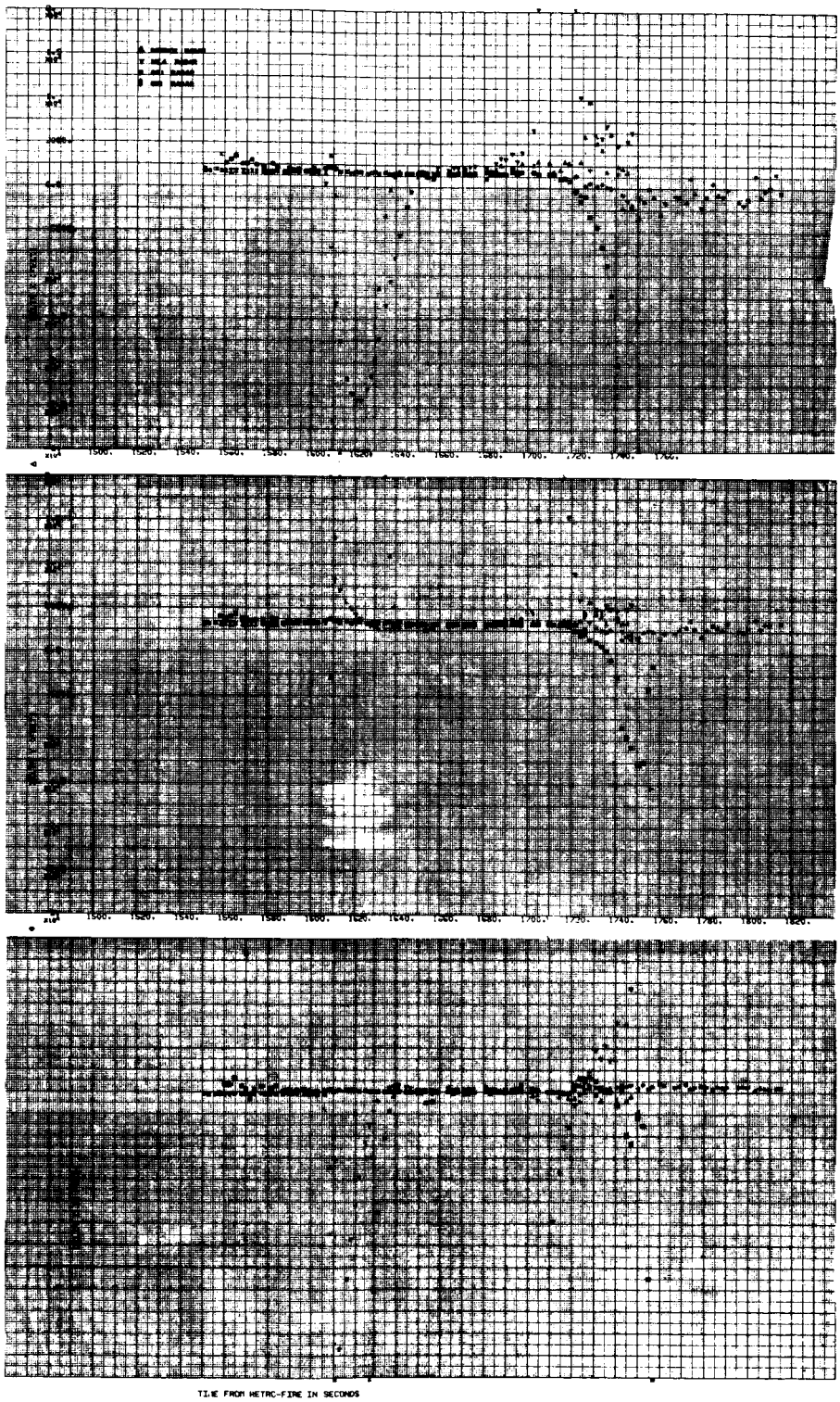


Figure 3-3. Corrected IGS - Radars in IGS Coordinates

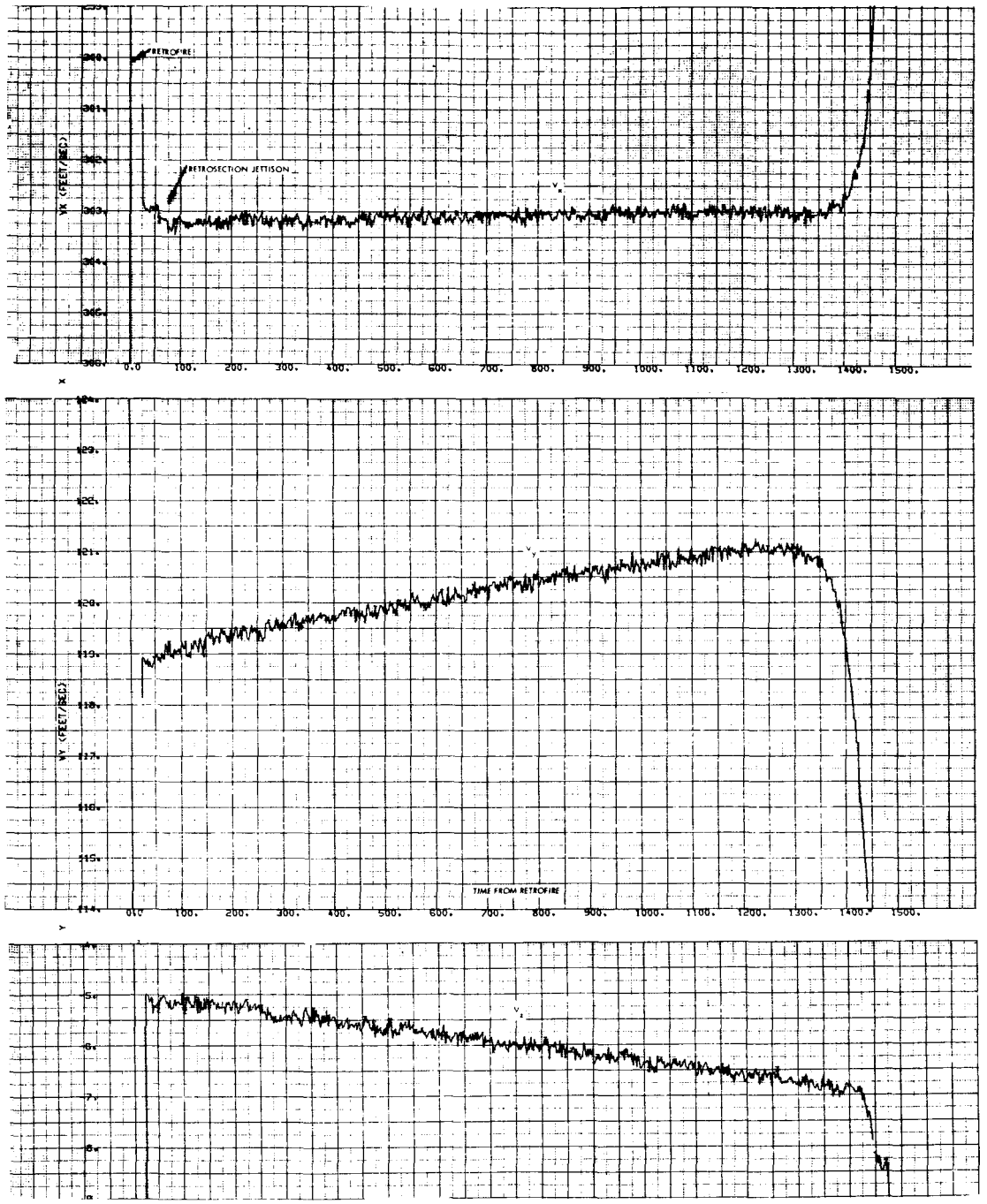


Figure 3-4. Post Retro IGS Indicated Sensed Velocity

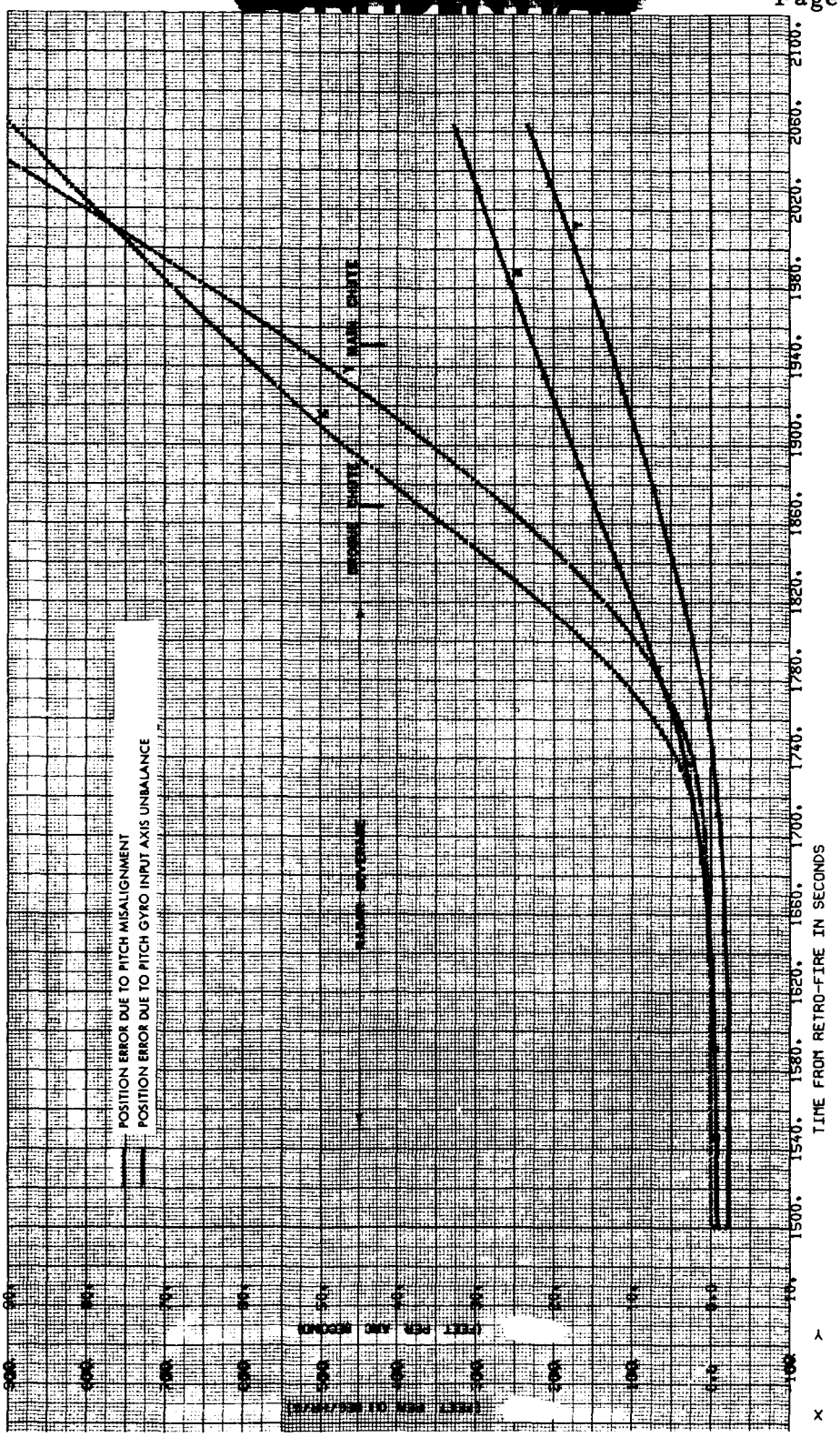


Figure 3-5. Reentry Error Functions

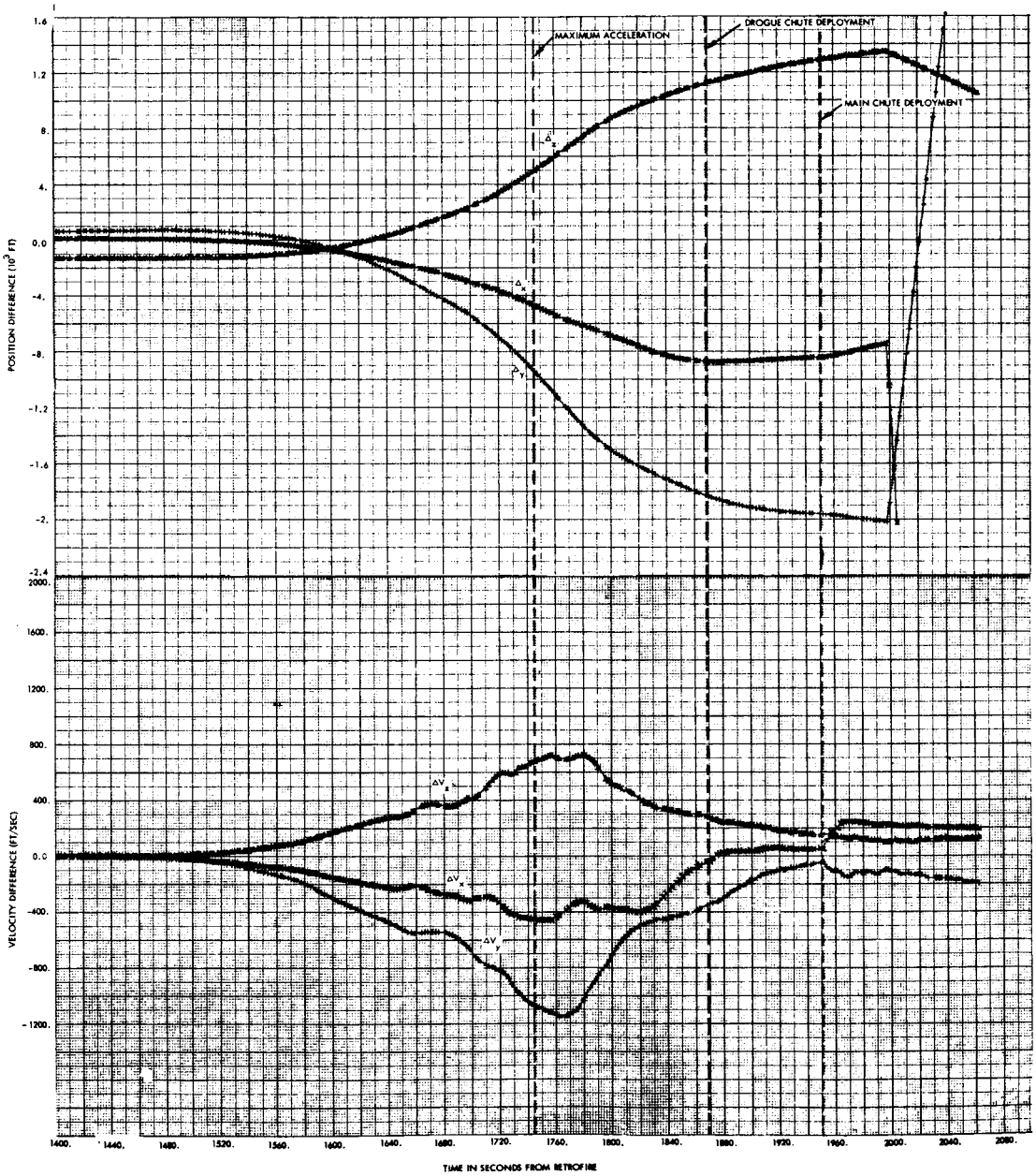


Figure 3-6. TRW BET - McDonnell Simulation Differences (IGS Coordinates)

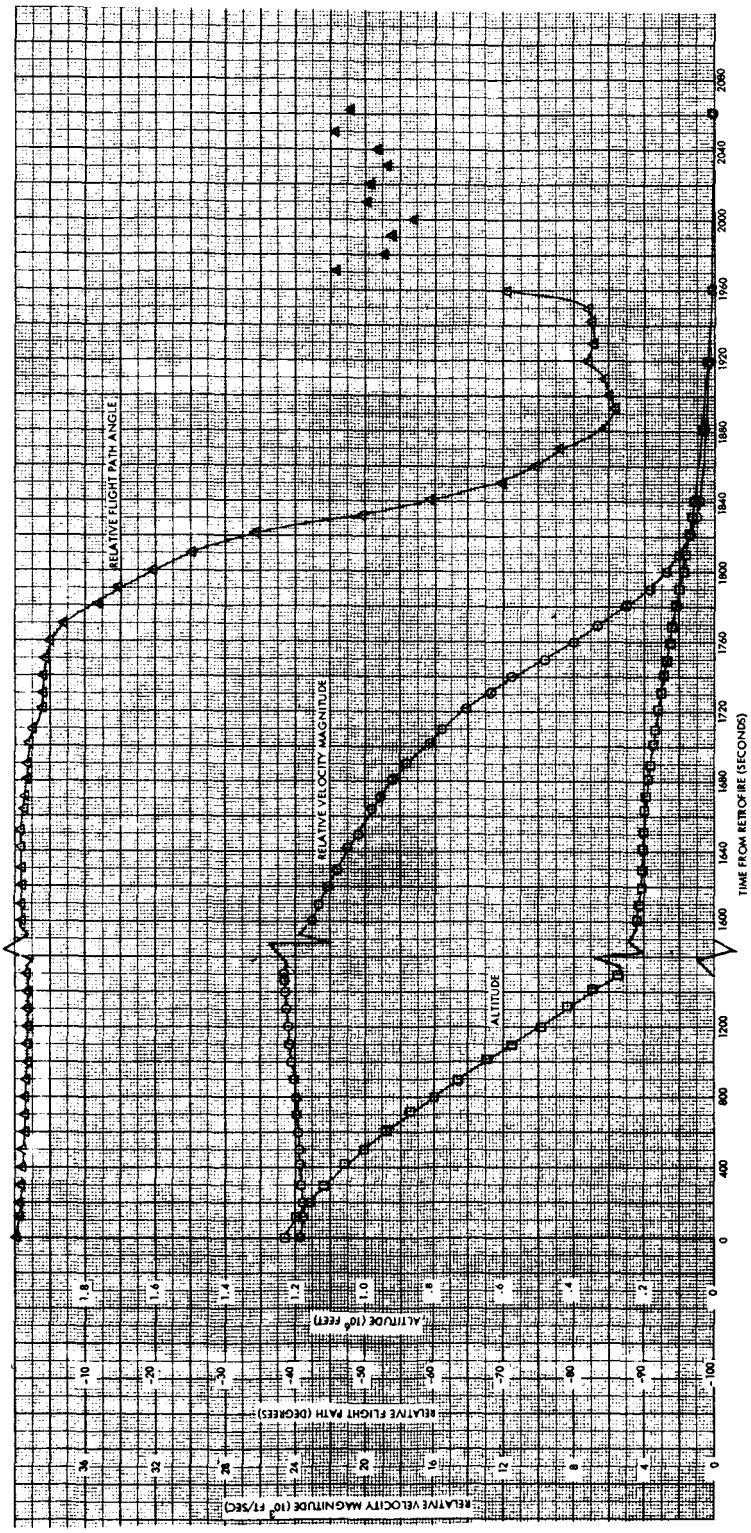


Figure 3-7. Reentry Trajectory Parameters

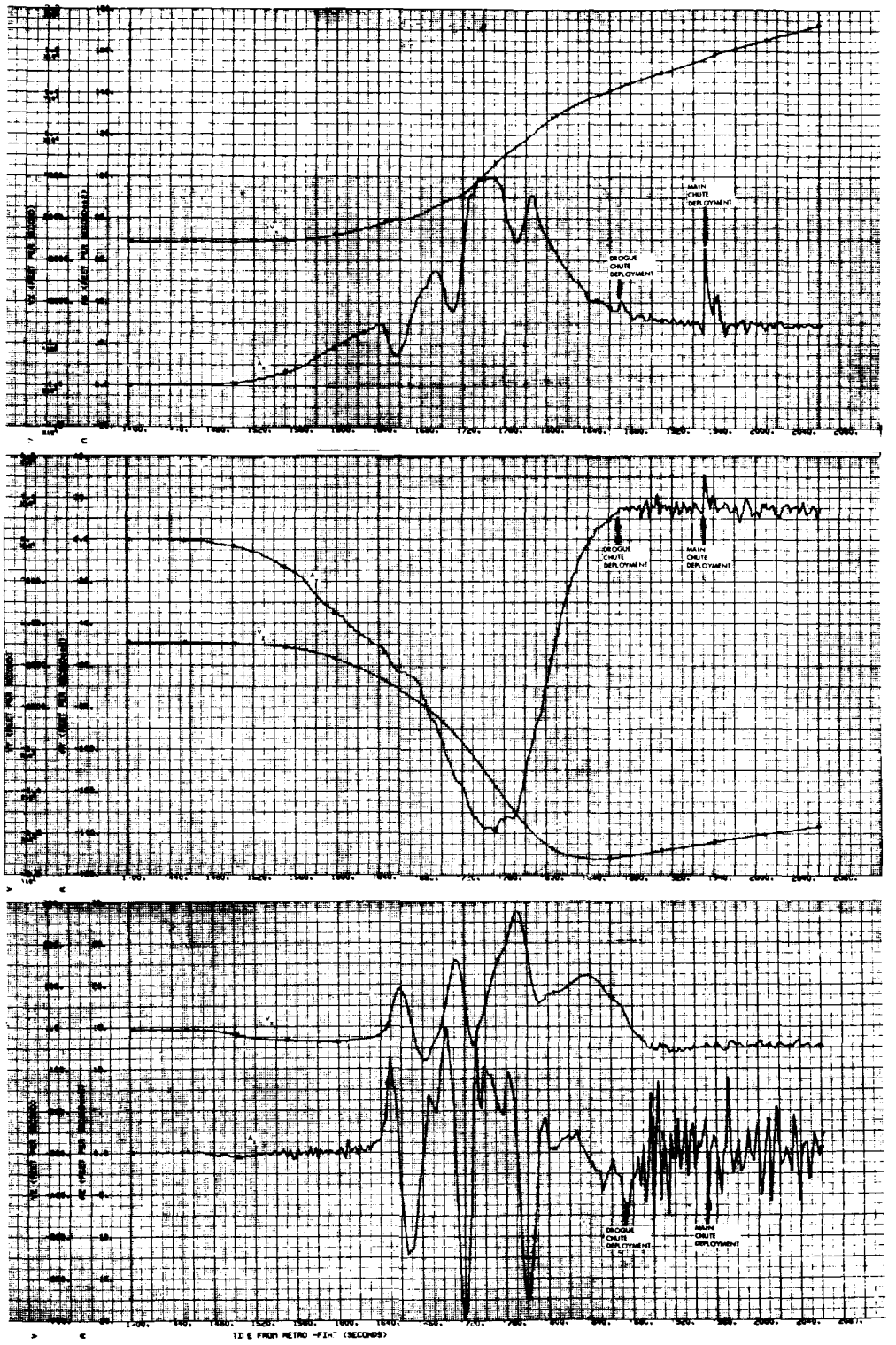


Figure 3-8. IGS Measured Sensed Velocities and Accelerations

4. TRACKING SYSTEM PERFORMANCE

This section provides an evaluation of the ascent phase tracking data which included the following:

a) GE MOD III Burroughs (TRW reduction)

b) GE MOD III Burroughs (GE reduction)

c) MISTRAM I quick-look 10K and 100K

d) AFETR MISTRAM — only BET (Glad reduction)

e) Air Force Eastern Test Range (AFETR) BET

Each of the above sets was used for position and velocity comparisons as described in Section 2. The TRW reduced GE MOD III Burroughs data were used for quick-look analysis, and the MISTRAM I and GE reduced MOD III Burroughs data were used for detailed analysis. The two AFETR BET's were also used to help substantiate the analysis.

Tracker error sources recovered from the ensemble IMU/tracking system analysis discussed in Section 2 are presented in Table 4-1. MISTRAM bias errors recovered from the AFETR BET programs are also presented for comparison purposes. The table shows that MISTRAM and GE errors were small on this flight and that there is good agreement among the error sources obtained from the separate analyses.

Figures 4-1 through 4-6 are comparisons of tracking data with inertial guidance data which had been corrected for IGS error sources derived from the IGS analysis (see Section 2). These are provided to give a clear indication of tracking data quality.

4.1 GE MOD III

4.1.1 GE MOD III Burroughs (TRW Reduction)

The GE/MOD III data, which consisted of raw counts recorded at a 2-per-second rate on punched paper tape, were transferred to magnetic tape at TRW and processed in the data reduction programs.

Figures 4-1 and 4-2 show comparisons of this data with compensated IGS data in IGS coordinates. The comparisons indicate that there

Table 4-1. Recovered Tracking Error Coefficients

System error	Units	TRW analysis		AFETR MISTRAM – Only BET		AFETR Final BET	
		Estimated bias	1σ uncertainty	Estimated bias	1σ uncertainty	Estimated bias	1σ uncertainty
R SUM	ft	- 5.0	1.0	-11.0	1.85	2.82	1.519
P 10K	ft	- 0.12	0.02	- 0.16	0.0075	-0.14	0.0006
Q 10K	ft	- 0.19	0.17	- 0.098	0.011	-0.08	0.008
P 100K	ft	- 0.50	0.10	- 0.75	0.077	-0.57	0.065
Q 100K	ft	**		- 0.62	0.10	-0.45	0.076
Refraction	n-unit	- 0.48	2.0				
R	ft	-23	3.8	N/U		N/U	
A	mrad	- 0.0027	0.016	N/U		N/U	
E	mrad	+ 0.044	0.011	N/U		N/U	
Refraction	n-unit	- 4.44	2.22	*		*	
Timing	sec	- 0.00061	0.00022	*		*	

*Not included in error model

**Could not be reliably extracted

N/U-GE MOD III position data not included in AFETR BET

Note: AFETR bias estimates were obtained from References 4 and 5.

is negligible tracking data position bias error, and the random and low frequency noise amplitude is large late in flight.

4.1.2 GE MOD III Burroughs (GE Processed)

The General Electric Company processes essentially the same 2-per-second MOD III Burroughs data; however more filtering and a refraction correction incorporating actual atmospheric conditions are applied. The GE processed data were available smoothed in both tracker natural measurement coordinates (R, A, E, $\dot{R}$, $\dot{P}$, $\dot{Q}$) and in ECI cartesian coordinates. The natural measurement coordinate data were used in the computer regression analysis and for plots included in this report.

Figures 4-1 and 4-2 also show the GE processed MOD III/compensated IGS differences. Comparisons with the TRW reduced MOD III clearly show the noise reduction resulting from the increased filtering incorporated in the GE data reduction. However, there are residual trends in the comparisons. The residuals of the GE processed data are for the most part attributed to errors in the tracking data which are partially explained by the GE MOD III errors presented in Table 4-1. From the error sources recovered, only the 4.4 n. unit refraction error contributes significantly to the observed IGS/tracker differences (0.08, +4.8 and +0.02 ft/sec in $\dot{x}$, $\dot{y}$, $\dot{z}$ respectively). The TRW processed data also show a refraction type error, but of opposite sign to the GE processed data.

4.2 MISTRAM

The MISTRAM I data received at TRW were fully scaled and corrected but unsmoothed Range Sum, P, and Q measurements. The data were processed in the usual manner to obtain IGS/MISTRAM I position and velocity comparisons.

Figures 4-3 and 4-4 show the MISTRAM I 10K and 100K/compensated IGS comparisons. The MISTRAM I 10K/IGS comparisons show no significant trends; however the MISTRAM 100K/IGS comparisons show trends resulting in approximately 0, +6.5, and +1 ft/sec $\dot{x}$, $\dot{y}$ and $\dot{z}$ errors respectively at SECO +20 seconds (t = 360). The TRW recovered MISTRAM I error sources presented in Table 4-1 contribute to the

explanation of these apparent velocity errors. The 6.5 ft/sec $\dot{y}$ residual is attributable to the -0.5 ft P_{100K} bias error which was the most significant error on this flight, but was much less than those observed on previous Gemini flights.

4.3 AFETR BEST ESTIMATE OF TRAJECTORY

The MISTRAM-only BET is computed by means of the AFETR GLAD program using MISTRAM I (10K and 100K) and MISTRAM II measurements. The solution is obtained from a least-squares adjustment of measurement biases and trajectory values. No refraction errors are solved.

The AFETR Final BET is a weighted least squares adjustment of measurements obtained from MISTRAM I and II, GE MOD III ($\dot{P}$, $\dot{Q}$, $\dot{R}$), and available FPQ-6 radar data.

Figures 4-5 through 4-6 show the AFETR MISTRAM only and Final BET's compared with compensated IGS data which is in fact the TRW BET (see Section 2). The comparisons show only small differences between the respective AFETR BETS. This is consistent with the essentially equivalent recovered MISTRAM error sources listed in Table 4-1. The AFETR MISTRAM-only and final BET's generally have agreed on Gemini flights. This is most likely because of relatively heavy weighting of MISTRAM I data in both BET solutions.

4.4 CONCLUSIONS

The tracking system performance was satisfactory, and MISTRAM I bias errors were small relative to previous flights. The GE MOD III data was of expected quality; however, there was an apparent 4 n. unit refraction error in the GE processed MOD III data.

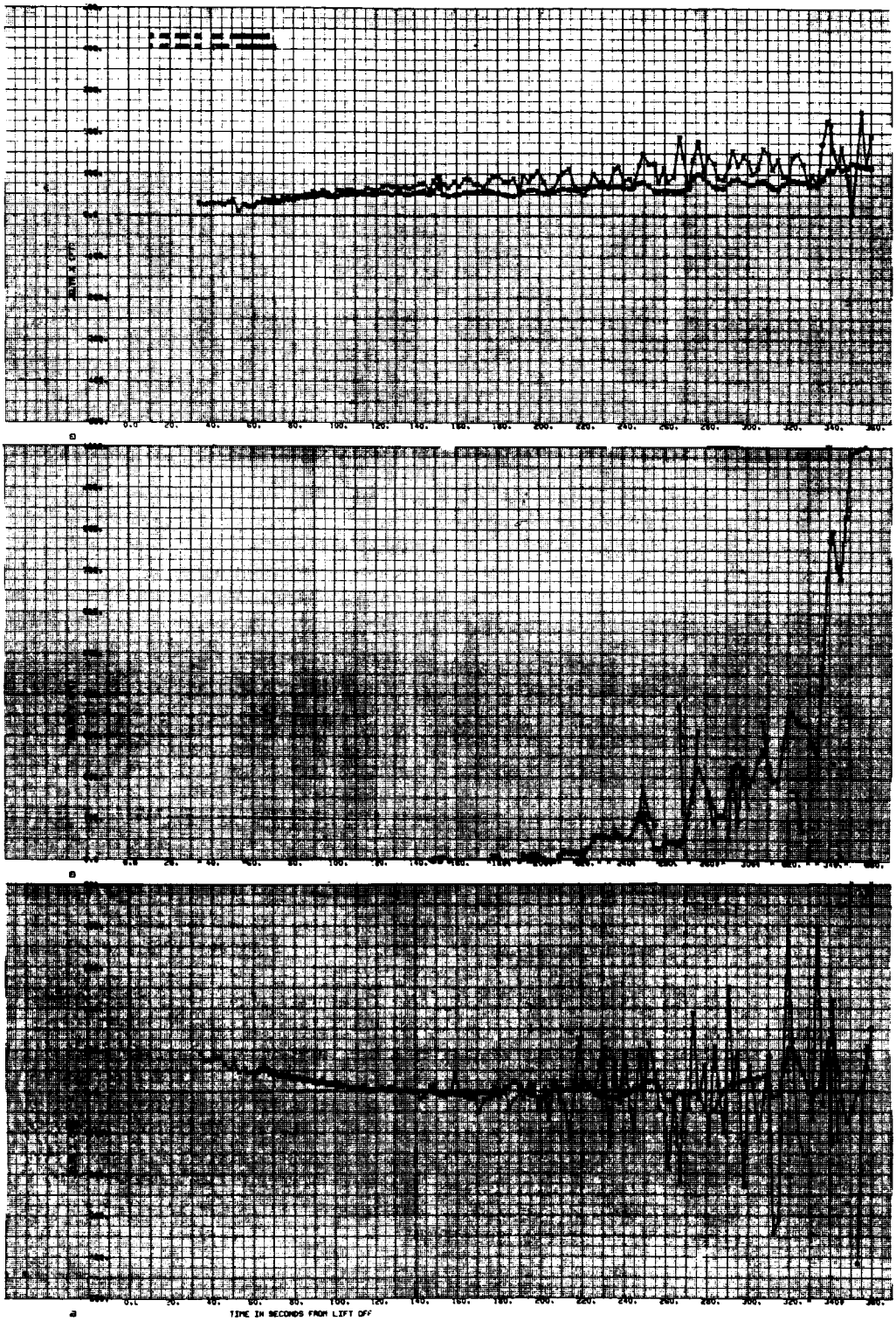


Figure 4-1. Sensed Position Comparison in Computer Coordinates (GE/Compensated IGS)

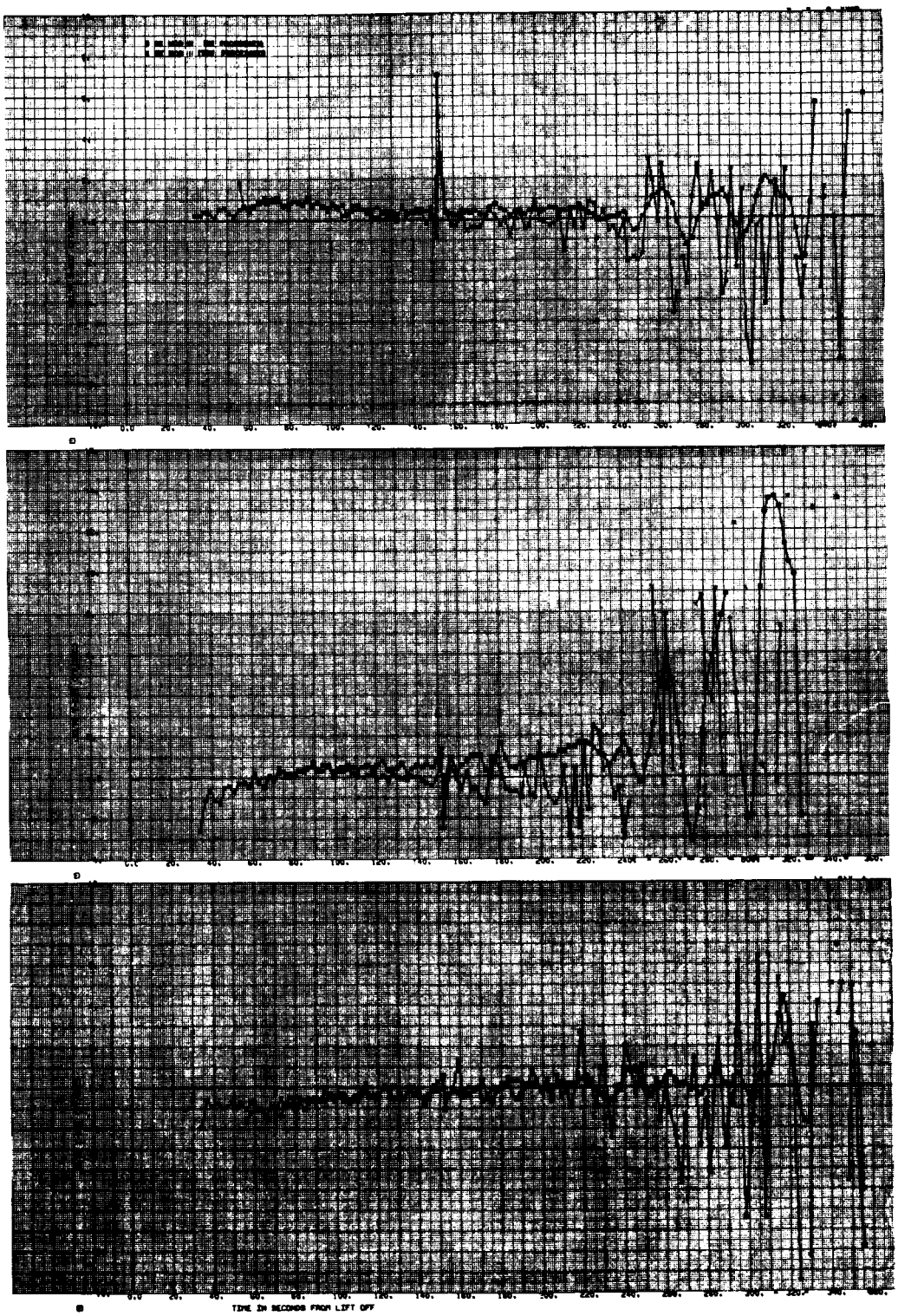


Figure 4-2. Sensed Velocity Comparison in Computer Coordinates (Mod III/Compensated IGS)

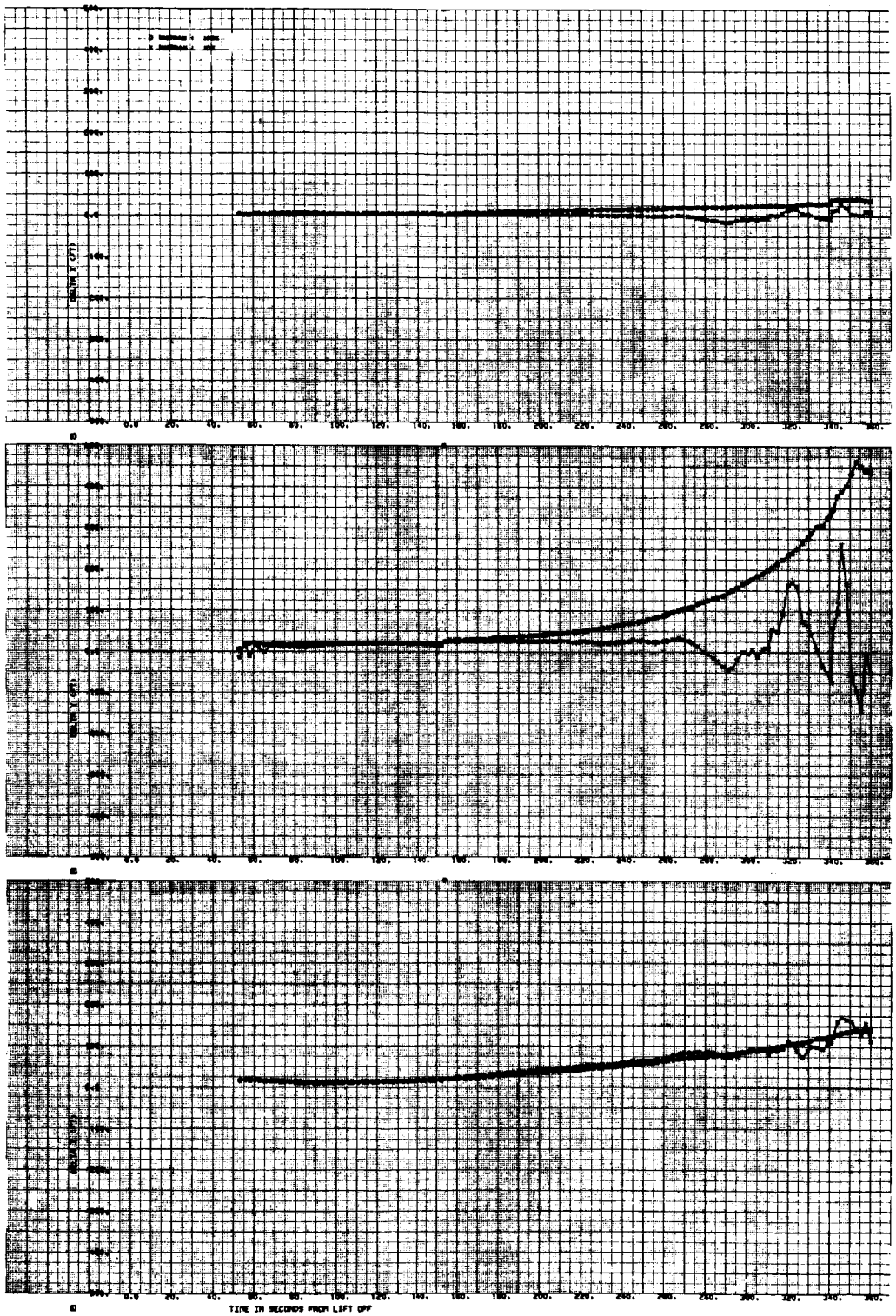


Figure 4-3. Sensed Position Comparison in Computer Coordinates (MISTRAM/Compensated IGS)

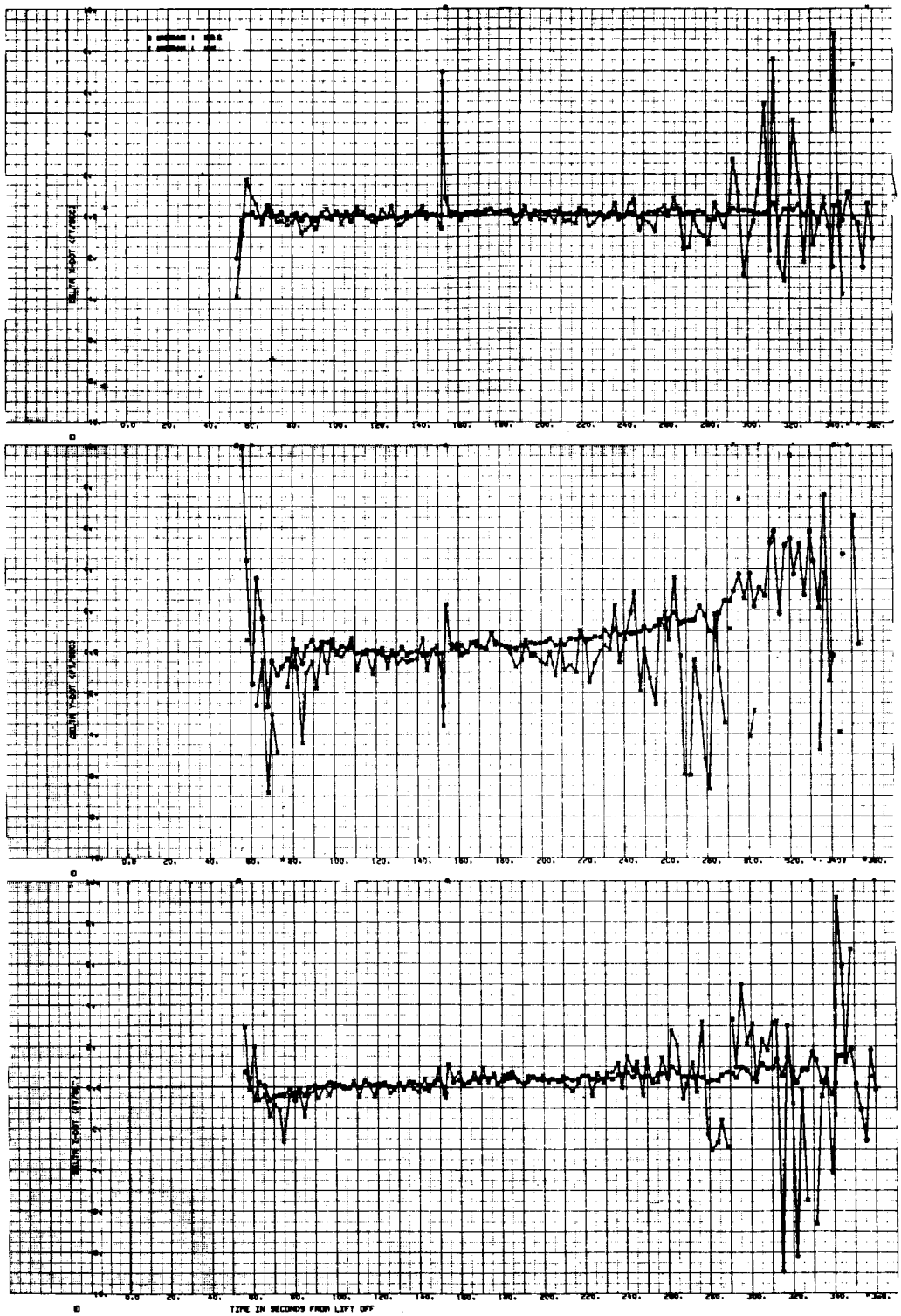


Figure 4-4. Sensed Velocity Comparison in Computer Coordinates (MISTRAM/Compensated IGS)

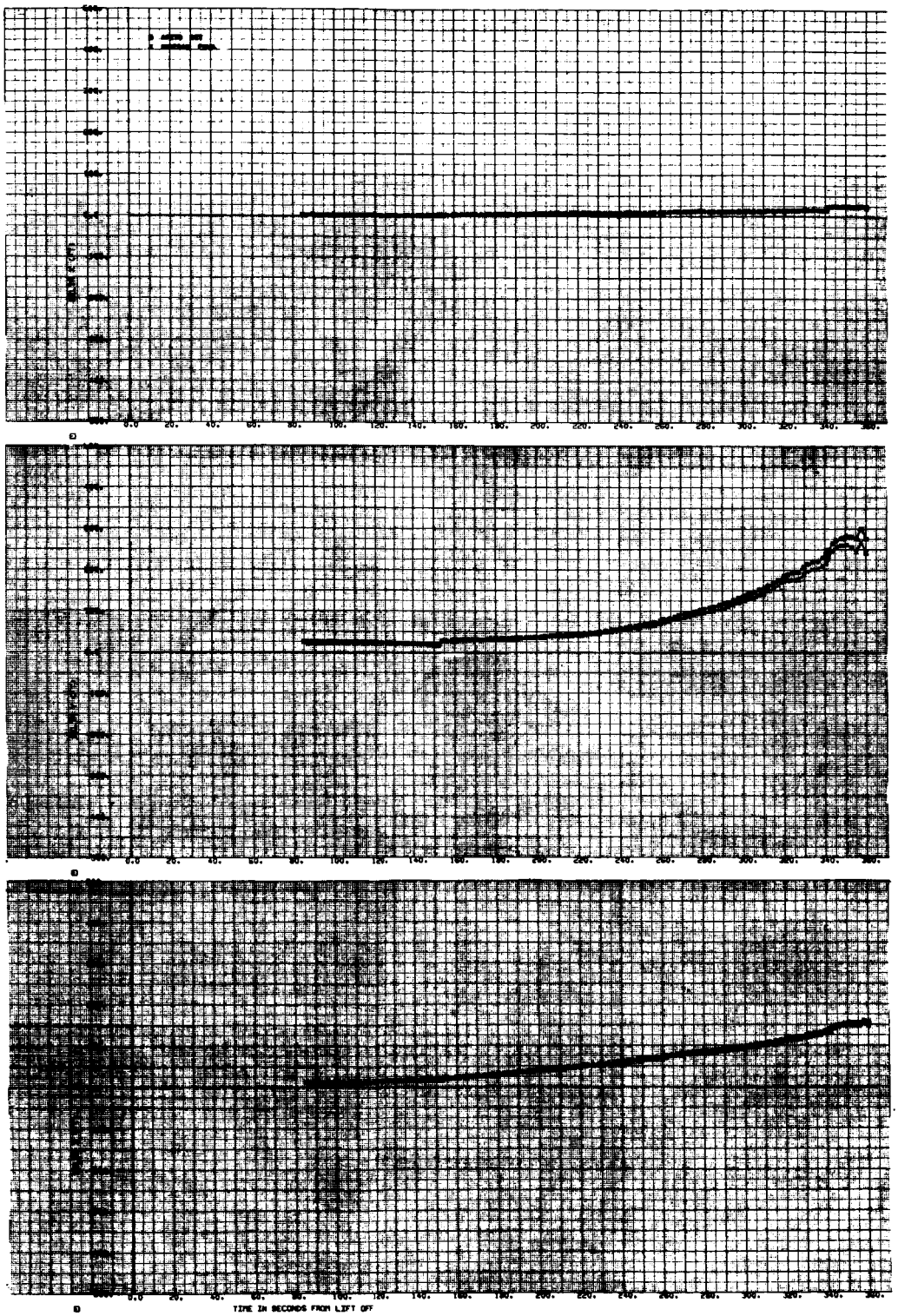


Figure 4-5. Sensed Position Comparison in Computer Coordinates Coordinates (BET and MF/Compensated IGS)

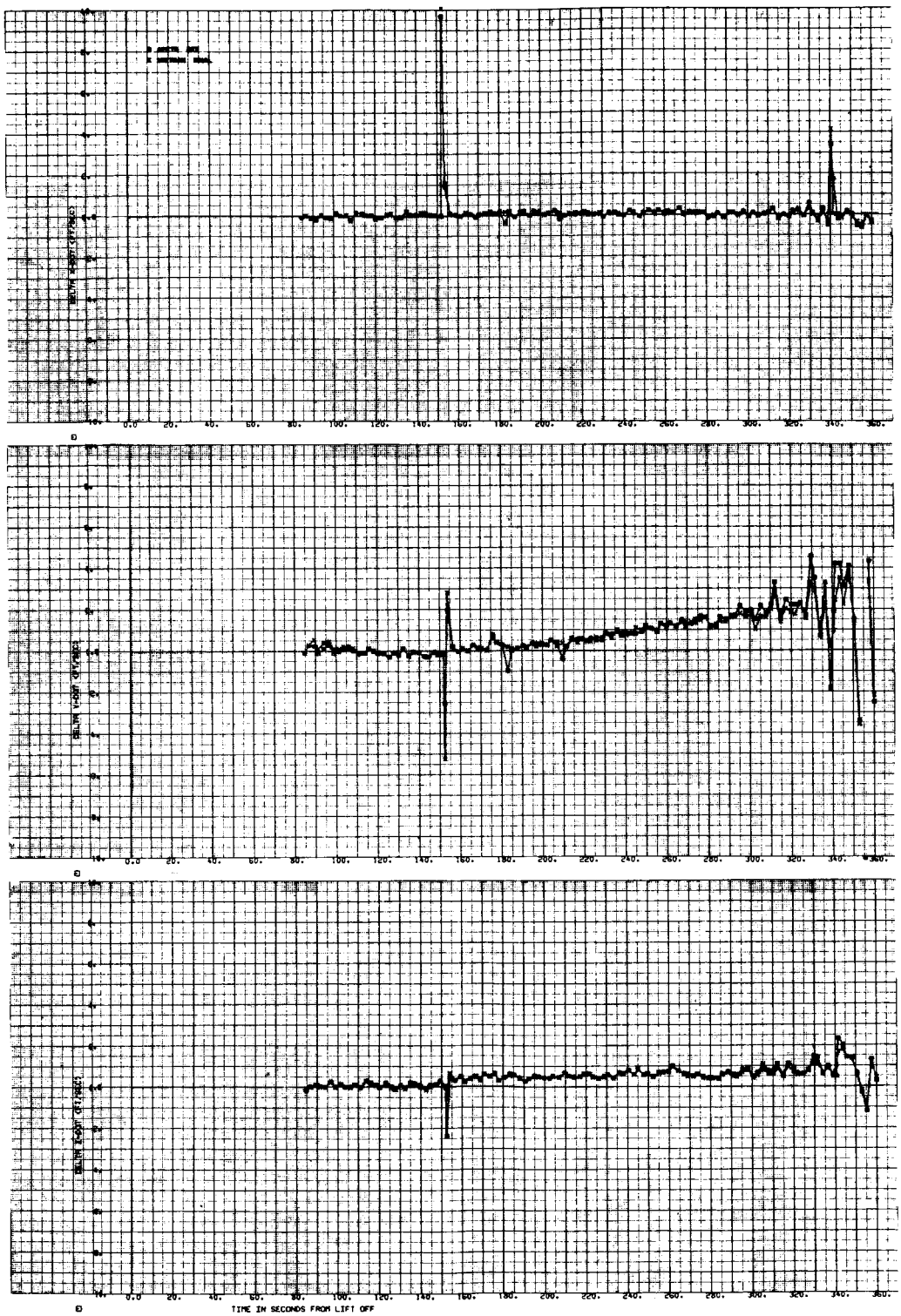


Figure 4-6. Sensed Velocity Comparison in Computer Coordinates (BET and MF/Compensated IGS)

5. RENDEZVOUS RADAR EVALUATION

5.1 INTRODUCTION

This section presents the results of the analysis of the Gemini 10 rendezvous radar. The radar evaluation was made by comparing the telemetered onboard radar measurements (range, azimuth, elevation) to values obtained by reconstructing the relative trajectories of the Gemini 10 spacecraft and the Agena 10 target vehicle (ATV). The comparisons were made over the interval of time from radar acquisition through the terminal phase maneuvers preceding the first rendezvous. Refer to Figure 5-1 for help in interpreting the directional sense of the radar angular measurements and the IGS platform gimbal angles. It should be remembered that the radar is hard-mounted to the Gemini spacecraft. Details of the orbit reconstruction of both the Agena and Gemini BET can be found in the TRW Gemini 10 Orbit Report (Reference 3).

5.2 TELEMETRY DATA

The telemetered radar parameters are plotted in Figures 5-2, 5-3, and 5-4. A cursory explanation of the data follows. Before 220 minutes GET, the spacecraft appears to be drifting within $\pm 10^{o}$ of the local horizontal. After this time but prior to platform alignment (238 minutes GET), the angular radar measurements were relatively constant at -7^{o} in elevation and $+1^{o}$ in azimuth; the relative range was between 120 and 100 n mi for this latter period. During alignment (238 to 253 minutes GET), the spacecraft must be held in the local horizontal; thus the elevation angle is offset by the angle between the Agena and the local horizontal and has a trend equal to the relative line-of-sight rate of the Agena. The azimuth measurements during alignment show a sinusoidal trend between plus and minus 3 degrees.

From the end of alignment to terminal phase finalization (TPF), the Agena was maintained near the spacecraft's boresight; i.e., the azimuth and elevation angles were near zero, as they should be for optimal radar accuracy.

5.3 TRAJECTORY RECONSTRUCTION

5.3.1 Agena 10 Trajectory

The Agena 10 trajectory was reconstructed using the TRW orbit determination program (ESPOD) to fit all ground tracking data from Agena insertion to rendezvous. Since there were no Agena maneuvers, the reconstructed trajectory was estimated to be accurate to within 1000 feet.

5.3.2 Gemini 10 Trajectory Reconstruction

For the Gemini 10 spacecraft, two trajectories were generated.

a) Gemini BET. This trajectory was made by fitting all ground tracking data over the interval of time from just after GT-10 insertion to TPF. IGS telemetric data were used to reconstruct the coelliptical (NSR) and the terminal phase maneuvers.

   Prior to the end of platform alignment there was heavy ground radar coverage of the spacecraft. After platform alignment, there was very little ground tracking data – HAW 03 (E_{MAX} = 15.6°) and CAL 03 (E_{MAX} = 5.4°) – occurring just prior to and immediately following TPI, respectively. Coupled with the fact that there were four maneuvers to be reconstructed, the lack of ground radar coverage decreases the accuracy of the GEMINI trajectory reconstruction as the terminal phase progresses. The following are estimates of the accuracy of the BET:

Prior to the end of alignment	1000 feet
Prior to TPI	1500 feet
After TPF	3000 feet

b) HAW 03 short arc fit. The ESPOD program was used to make a single station curve fit on the HAW 03 radar data which were collected just prior to TPI. This fit was made to check the accuracy of the BET during the interval of time that the spacecraft passed over Hawaii. The short arc fit agreed with the BET to within 1500 feet and this discrepancy was most likely caused by an apparent -0.03 degree elevation bias in this station.

5.4 ANALYSIS OF RENDEZVOUS RADAR OUTPUT

The Tracking Radar Analysis Program (TRAP) was used to compare the onboard radar data with the TRW calculated trajectories. The

comparison was made in radar coordinates using telemetered gimbal angles to transform from IGS to body coordinates. The results are plotted in Figures 5-5, 5-6, and 5-7. Also annotated on these plots are the maneuver initiation times, the period of platform alignment, and the relative range of the Agena with respect to the spacecraft. The analysis was divided into four segments:

- Prior to platform alignment
- During alignment
- End of alignment to TPI
- TPI through TPF.

Table 5-1 gives the average residual magnitudes in range, azimuth, elevation, and total position, as well as an estimate of the uncertainty of the TRW relative trajectory for each of the above time intervals.

Prior to the platform alignment, it was estimated that the TRW reconstructed relative trajectory was accurate to approximately 1500 feet.

The elevation angle residuals (Figure 5-7) show a relatively constant offset of 2.5 degrees from 208 to 219 minutes GET, and then a shift to a much smaller difference of approximately 0.3 degree, which is then maintained nearly constant until alignment. During approximately the same period the azimuth residual (Figure 5-6) grows from a small value to a peak at 3 degrees and back to 0.5 degree, which is then nearly the same until alignment. Since the relative range was greater than 100 miles, these radar angle excursions represent total position differences of greater than 4 n.mi. Therefore, the error is clearly in the radar/platform measurements. An error of this shape is difficult to imagine in the platform alignment and, therefore, it was concluded to be a radar angle error. As seen in Figure 5-4, the target vehicle was considerably off the spacecraft's boresight, and it may be partially due to this fact that the radar angular measurements were relatively inaccurate.

During the period of platform alignment, the azimuth residuals show the same ±3 degree variations as noted in the total azimuth measurement (see Figures 5-3 and 5-6). These relatively abrupt changes must be due to onboard measurement error, since any bias error in the TRW-calculated azimuth is smooth. [MSC analyses of the horizon scanner/platform servo loop outputs indicate that the platform was momentarily torqued out of alignment. Approximately 80 percent of the misalignment was due to a spacecraft roll error which resulted in the platform misalignment. MSC also noted that some period of valid alignment mode remained even after the perturbation. This being the case, it would be expected that the major alignment error would be in the yaw direction. This error must be corrected by relatively slow gyrocompassing. The horizontal (pitch and roll) error would be more rapidly corrected by the horizon scanner.]

In any case, between the end of platform alignment and TPI, the azimuth residuals average -1.8° and the elevation residuals -0.5°, representing a total position residual of greater than 2 miles. The TRW calculated trajectory is, with good probability, accurate to within 2000 feet. It is therefore most likely that there was an error in either the platform alignment or the radar, or both. Since there is no evidence of this size radar azimuth bias prior to alignment and the error is closely correlated with alignment, it appears that a platform misalignment of $-1.9 \pm 0.5^{\circ}$ in the yaw direction (platform oriented left of the true downrange direction) was the cause of the large total position error. Similarly, the estimated post alignment error in the pitch (elevation) alignment, Figure 5-7, is $-0.6 \pm 0.5^{\circ}$ (the platform is pitched down from true horizontal).

Assuming the platform was misaligned in yaw, the error will appear in azimuth in the comparison, but decreasing in magnitude as the initial yaw direction is transformed to roll due to the orbit rate. If an initial yaw misalignment were the only error in the compared quantities, the azimuth error (Figure 5-6) should change as cos ($\omega\Delta t$), $\omega\Delta t$ being the angular travel of the spacecraft after "alignment." The curve, $\Delta A = 1.9^{\circ}$ cos ($\omega\Delta t$), is shown in Figure 5-6. There is some indication that the observed error curve is decreasing as postulated before TPI. There is

no agreement with the curve after TPI, which could be due to one or a combination of the following causes:

a) The unknown initial roll misalignment is coupling into the azimuth comparison as initial roll becomes yaw with orbital travel

b) The onboard radar has an azimuth bias error (though this is not completely consistent with the prealignment ΔA which shows a "bias" in the opposite direction)

c) The trajectory reconstruction error is distorting the comparison.

The last cause is very likely, since the relative range at 280 minutes GET has decreased to 150,000 feet and the assumed trajectory uncertainty of 3,000 feet during this period represents a 1 degree angle uncertainty.

The range comparison, Figure 5-5, shows a sinusoidal trend suggestive of a trajectory reconstruction error. However, it is noted that over the entire comparison range, from 150 miles to a few thousand feet, the difference is within 1,000 feet. This comparison adds considerable confidence both to the accuracy of the reconstruction and the radar range measurement.

5.5 CONCLUSIONS

a) During the radar tracking interval preceding platform alignment (208 to 224 minutes GET) radar/platform angle error trends of up to 3 degrees were evident. The error was most likely in the radar measurement.

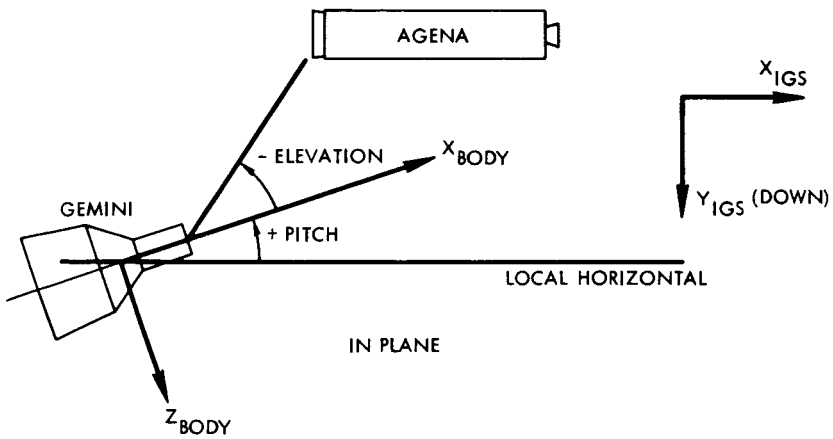
b) During platform alignment, the azimuth angle residuals showed excursions of ±3 degrees, indicating possible problems in alignment. [MSC analysis indicated the platform was momentarily torqued out of alignment due to a spacecraft roll error.]

c) After platform alignment, there is an indicated radar platform system misalignment: yaw/azimuth misalignment = $-1.9 \pm 0.5^{\circ}$, pitch/elevation misalignment = $0.6 \pm 0.5^{\circ}$.

d) No radar range error is evident to within the accuracy of the trajectory reconstruction, 1000 to 3000 feet.

Table 5-1. Average Magnitude of Residuals (Radar — Calculated)

Time	$\|\Delta R\|$ (ft)	$\|\Delta A\|$ (deg)	$\|\Delta E\|$ (deg)	Δ Position (n. mi.)	Estimated Accuracy of Calculated Trajectory
Prior to alignment	497	0.8	1.3	4.0	0.25
During alignment	476	1.4	0.7	2.4	0.25
Alignment - TPI	277	1.8	0.6	2.3	0.33
TPI - TPF	721	0.7	0.4	0.2	0.50



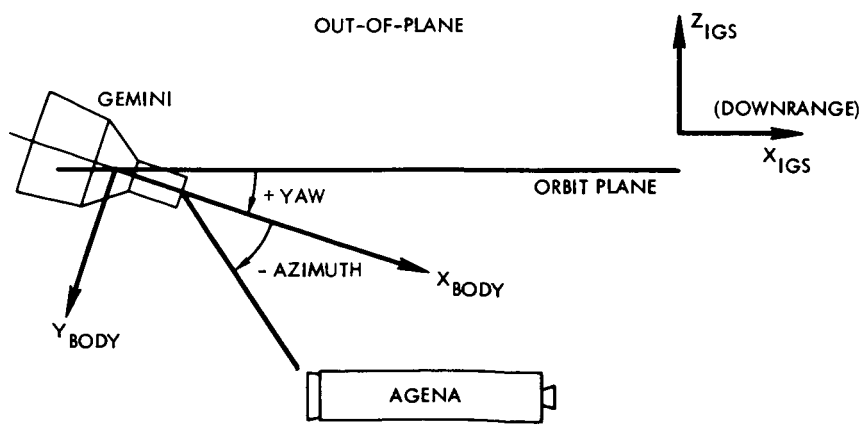


Figure 5-1. Rendezvous Geometry

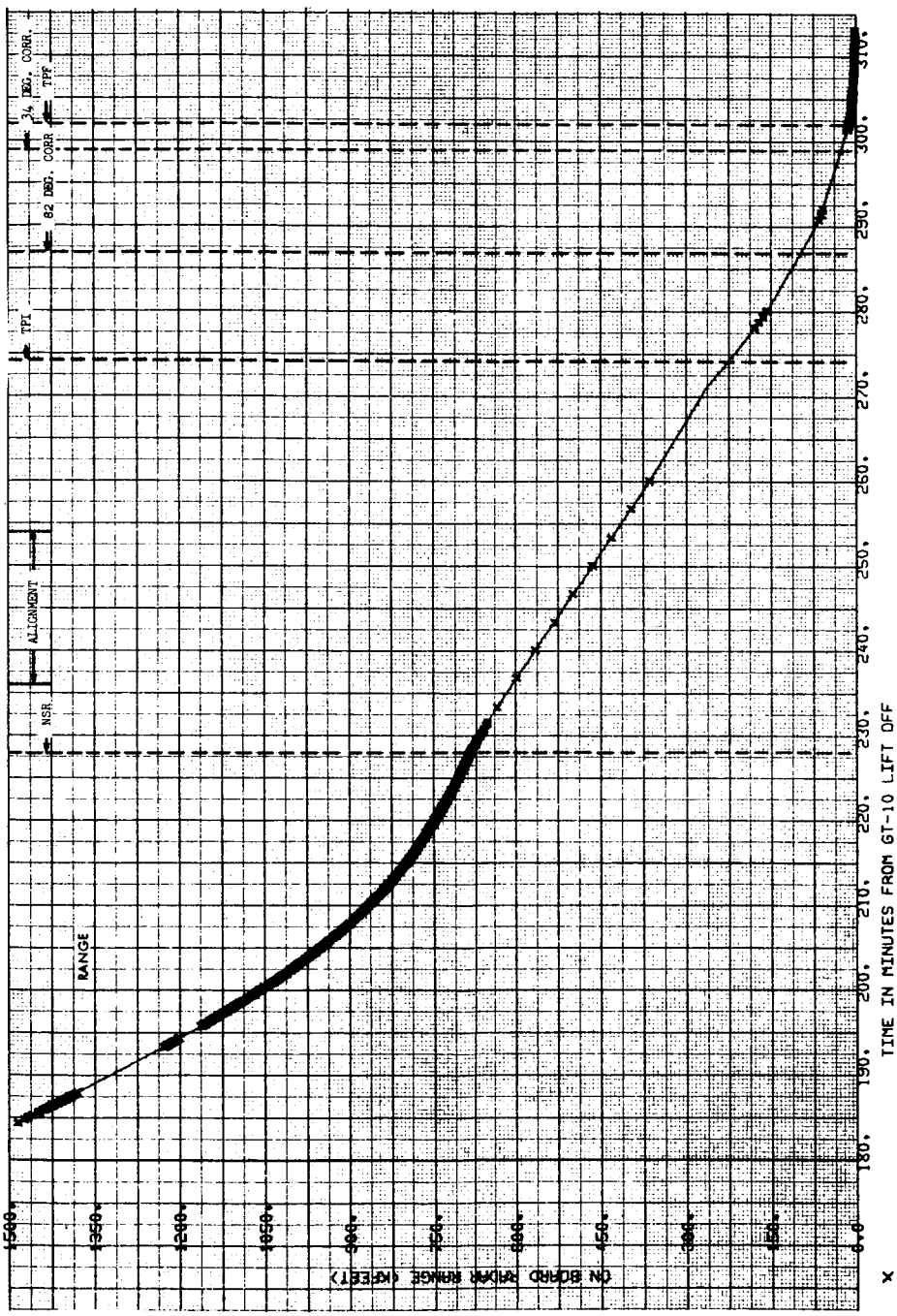


Figure 5-2. Radar Telemetered Parameters (On Board Radar Range)

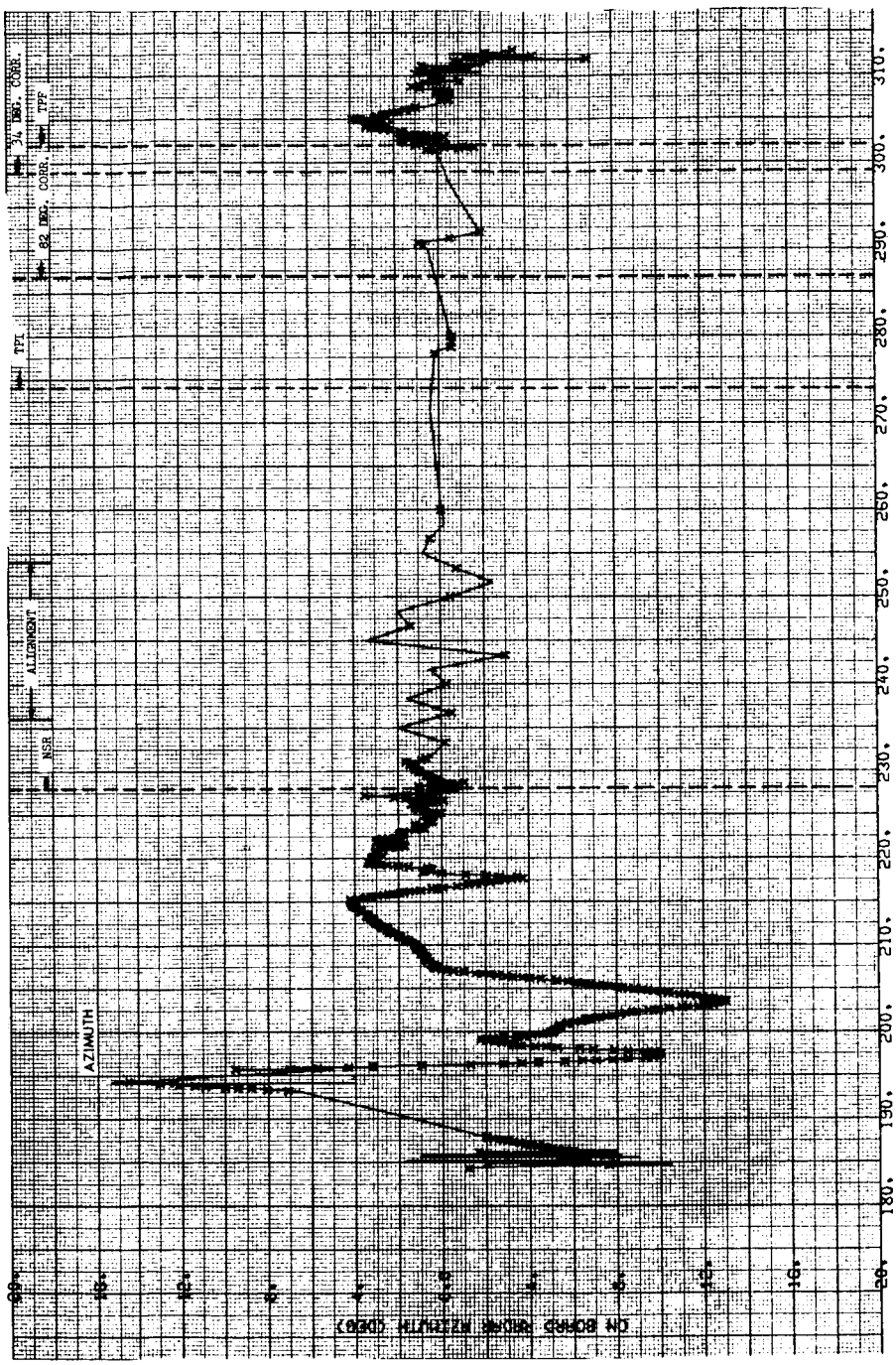


Figure 5-3. Radar Telemetered Parameters (On Board Azimuth)

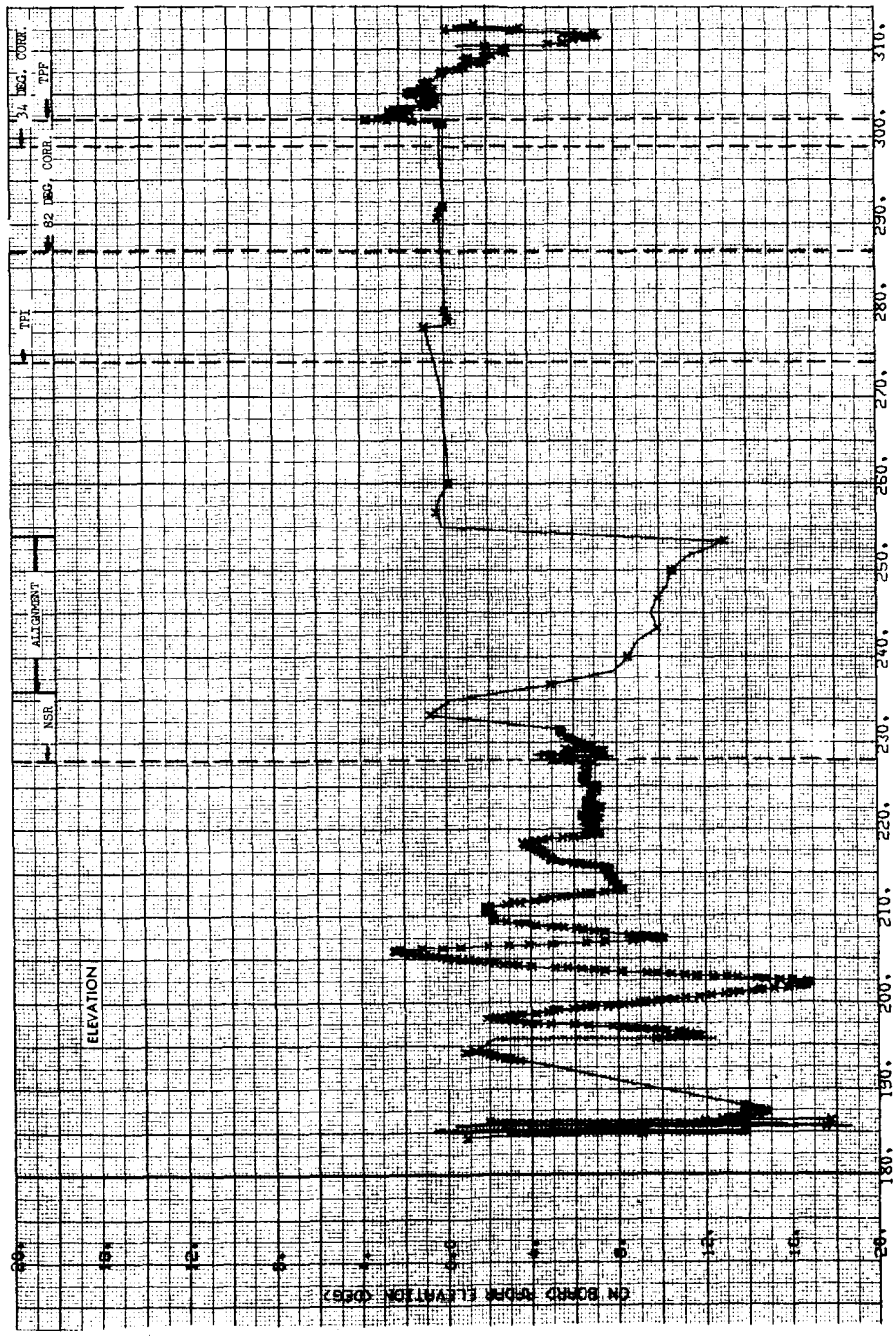


Figure 5-4. Radar Telemetered Parameters (On Board Radar Elevation)

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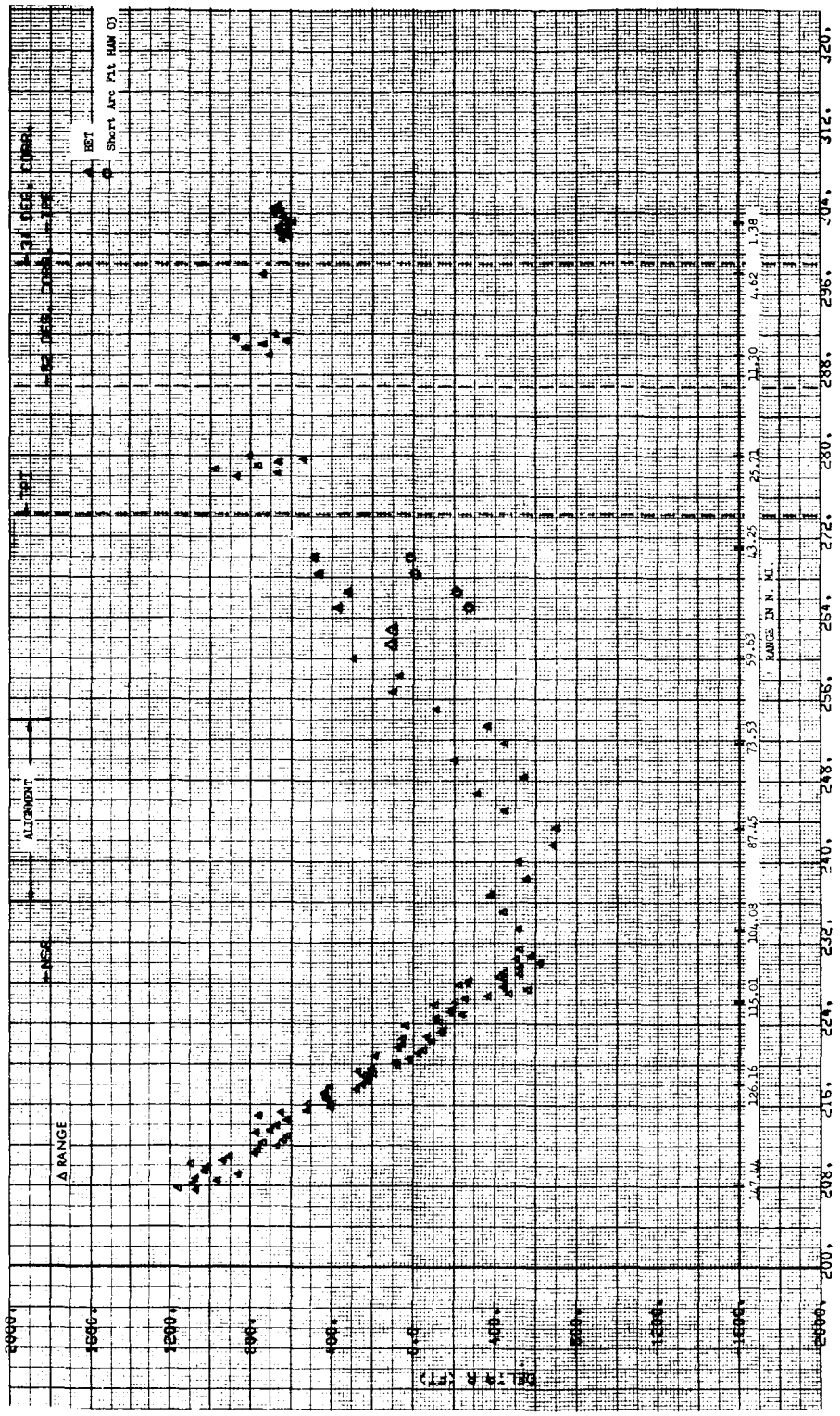

Figure 5-5. Radar Residuals (Telemetered Range Minus TRW Calculated Range)

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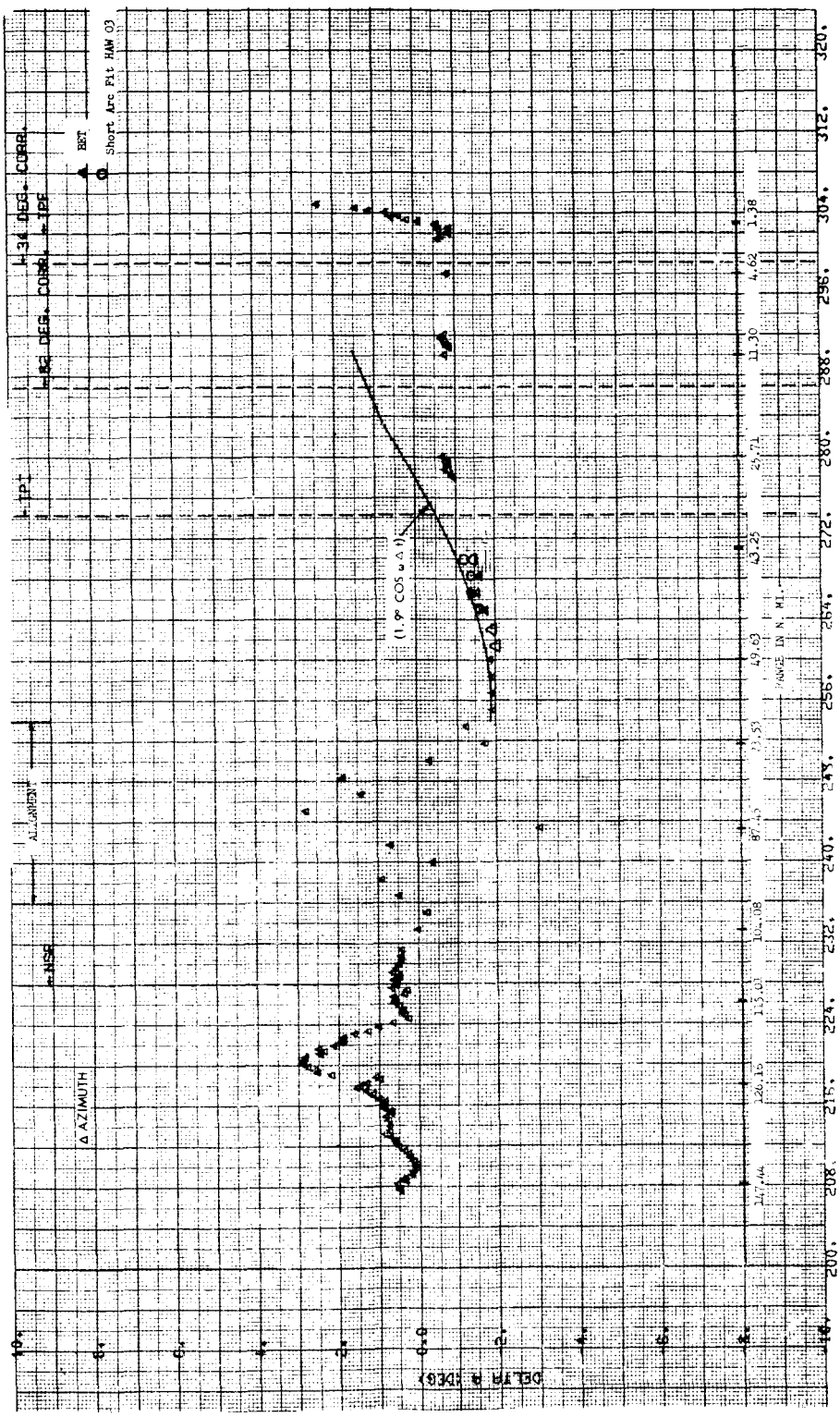

Figure 5-6. Radar Residuals (Telemetered Azimuth Minus TRW Calculated Azimuth)

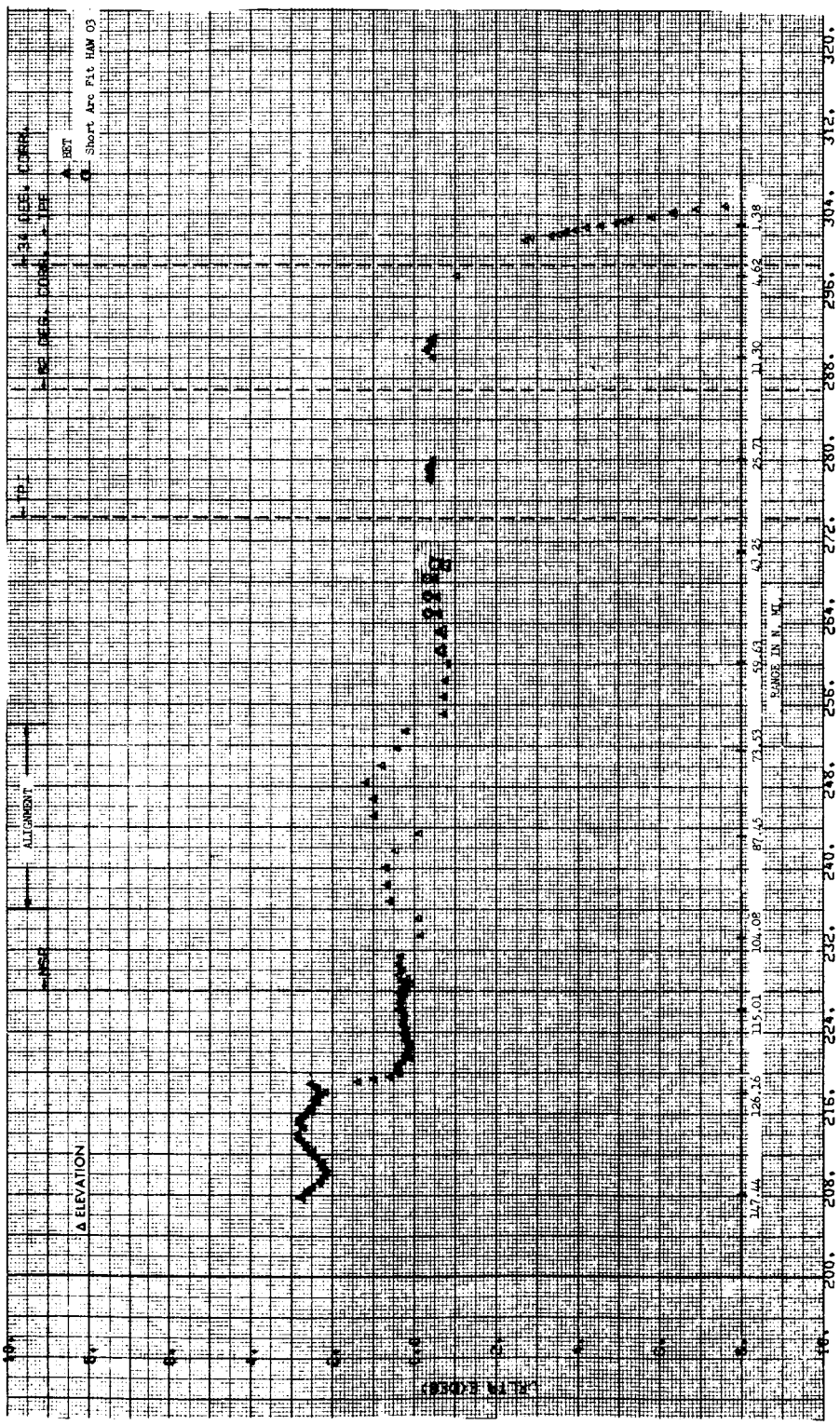

Figure 5-7. Radar Residuals (Telemetered Elevation Minus TRW Calculated Elevation)

6. ANALYSIS OF SEXTANT SIGHTINGS ON GEMINI 10

6.1 INTRODUCTION

During the flight interval between $0^h\ 7^m\ 25^s$ and 2^h GET, the celestial altitudes of six stars were measured by the astronaut with a hand-held sextant. This section presents comparisons of these sextant sightings with calculated values derived from a TRW-reconstructed Gemini 10 trajectory. The TRW reconstruction (TRW BET) was obtained by fitting a best orbit in a minimum variance sense to the ground radar tracking data on the first two Gemini orbits. The estimated accuracy of this trajectory is ±1500 feet.

6.2 HORIZON BIAS

Table 6-1 shows results of six calibration measurements made on the star Schedar to establish the difference between the earth's hard crust horizon and a horizon determinable by visual means. Calculated altitudes using the TRW BET are shown for comparison. Onboard computations using this data resulted in a value of 27,500 yards for the horizon bias, and this value was used in the onboard computer to correct the other measured star altitudes. MSC postflight analysis of the bias computation indicated that 32,000 yards was a better estimate of the bias. The 4500-yard altitude difference results in a star angle bias of approximately 0.14 degrees in all onboard measurements. The TRW estimate of 31,500 yards was obtained by eliminating the first and last observation as wild points and averaging the four remaining differences.

6.3 SEXTANT MEASUREMENTS

The results of four-star altitude measurements made for trajectory updating are presented in Table 6-2 and compared with the TRW BET calculated values. The comparison was made assuming that a horizon bias of 32,000 yards was included in the measurement. Therefore, the last column in the table represents unexplained measurement error.

Table 6-1. Horizon Bias

Ground elapsed time (sec)	Measured Schedar altitude (deg)	TRW BET calculated Schedar altitude (deg)	Difference (measured minus TRW) (deg)
1509.500	4.446	6.56	-2.11
1626.875	8.749	7.60	1.15
1685.875	9.087	8.16	0.93
1760.000	9.849	8.90	0.95
1822.625	10.399	9.51	0.89
1892.375	10.842	10.24	0.60
	Onboard bias	27,500 yards	
	MSC bias	32,000 yards	
	TRW bias	31,500 yards	

Table 6-2. Star Altitude Measurement Comparison

Star	Ground elapsed time (sec)	Star altitude (deg)		
		Measured	TRW BET calculated*	Difference (measured - TRW)
Hamel	2424	32.67	32.63	0.04
Vega	2654.5	8.44	7.58	0.86
Fomalhaut	6451.875	9.09	8.83	0.26
Arcturus	7112.125	18.02	17.71	0.31

*Bias = 32,000 yards

6.4 ONBOARD COMPUTATIONS

These sextant sightings were used to update an onboard reference trajectory. This reference trajectory was propagated from the state vector stored in the IGS at insertion, which resulted from the IGS navigation throughout ascent. The error in this insertion vector was determined as part of the ascent IGS error analysis summarized in Table 2-8 of Section 2.

A comparison between the onboard reference trajectory and the TRW postflight reconstructed trajectory resulted in the following average differences in classical orbital elements.

Right ascension of ascending node	= 0.0225 degrees
Inclination	= 0.00308 degrees
Argument of perigee	= 3.6 degrees
Semimajor axis	= -280 feet
Eccentricity	= 0.0001
Period	= -0.0018 minutes

The relatively large error in the argument of perigee reflects the 13 feet per second IGS error in the vertical direction ($\dot{y}$) at insertion. This IGS ascent phase navigation error causes the onboard reference orbit to be rotated inplane from the true trajectory. The Cartesian coordinate differences, therefore, vary considerably as the calculated and true trajectory come into agreement periodically. The range of error over the period of interest is

$$\vec{\Delta P} = 5000 - 50,000 \text{ feet}$$

$$\vec{\Delta V} = 19 - 50 \text{ feet per second}$$

The residual between the observed, bias corrected altitude and the onboard calculated altitude is also a telemetry quantity. Table 6-3 shows this telemetry quantity along with the TRW simulation of the residual.

Table 6-3. Star Altitude Residual Comparison

	Altitude (deg)		Residuals (deg)		
	Measured	TRW-simulated IGS value*	Measured minus TRW simulated	Measured minus IGS (telemetered)	ΔΔ
Hamel	32.67	32.69	-0.02	-0.02	0.00
Vega	8.44	7.54	0.90	-	-
Fomalhaut	9.09	9.04	0.05	-0.15	-0.20
Arcturus	18.02	17.67	0.35	0.35	0.00

*Bias = 27,500

The "TRW-simulated IGS value" was derived by propagating the onboard, IGS initial state vector by means of the integration of the TRW orbit determination program ESPOD. This TRW/IGS trajectory was used to calculate the respective star altitudes and the results differenced with the telemetered star altitude measurements. For comparative purposes the altitude bias was assumed to be 27,500 yards for the TRW-simulated values. The TRW calculated residuals, therefore, are a simulation of the onboard computations, but using a different trajectory propagation model. The TRW simulation also used the oblate earth radius at the horizon point, where the onboard computations assume a constant earth radius in the calculation of the star altitudes. There are perhaps other minor differences in the simulation, but collectively the onboard calculations are expected to have an accuracy of better than 0.01 degree. The last column of Table 6-3 is a comparison of the TRW-simulation and onboard results and indicates internal consistency to better than 0.01 degree for Hamel and Arcturus. The large difference for Fomalhaut may indicate that an incorrect time was associated with this telemetered angle reading as the result of a data reduction error.

If it is assumed that the onboard computer computations are accurate, which is the case for Hamel and Arcturus, and that the residual difference for Fomalhaut reflects a systematic error in the

TRW-simulation due perhaps to a time mismatch, then the sign sense of the residual difference is such that the TRW-simulated altitude will read larger by 0.20 degrees. The TRW calculated altitude for Fomalhaut in Table 6-2 should then also be increased by 0.20 degree. This adjustment would reduce the unexplained error in the astronaut measurement of Fomalhaut to 0.06 degree.

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APPENDIX A

ASCENT TRAJECTORY

The ascent trajectory is provided in three separate forms: a) guidance coordinates as sensed by the accelerometers (these data are uncorrected for errors determined during flight); b) an earth-centered inertial coordinate set; and c) various special earth-referenced parameters. The latter two have been corrected for apparent IGS errors and therefore represent the TRW best estimate of the ascent trajectory.

The earth-centered inertial coordinate system has the z axis aligned with the earth's rotational axis, positive north, and the x-y plane is in the equatorial plane with the x-z plane containing the Greenwich meridian at platform release time (18 July 22^h20^m 26.648 GMT). Time is referenced to liftoff, which occurred 3.260 seconds after platform release.

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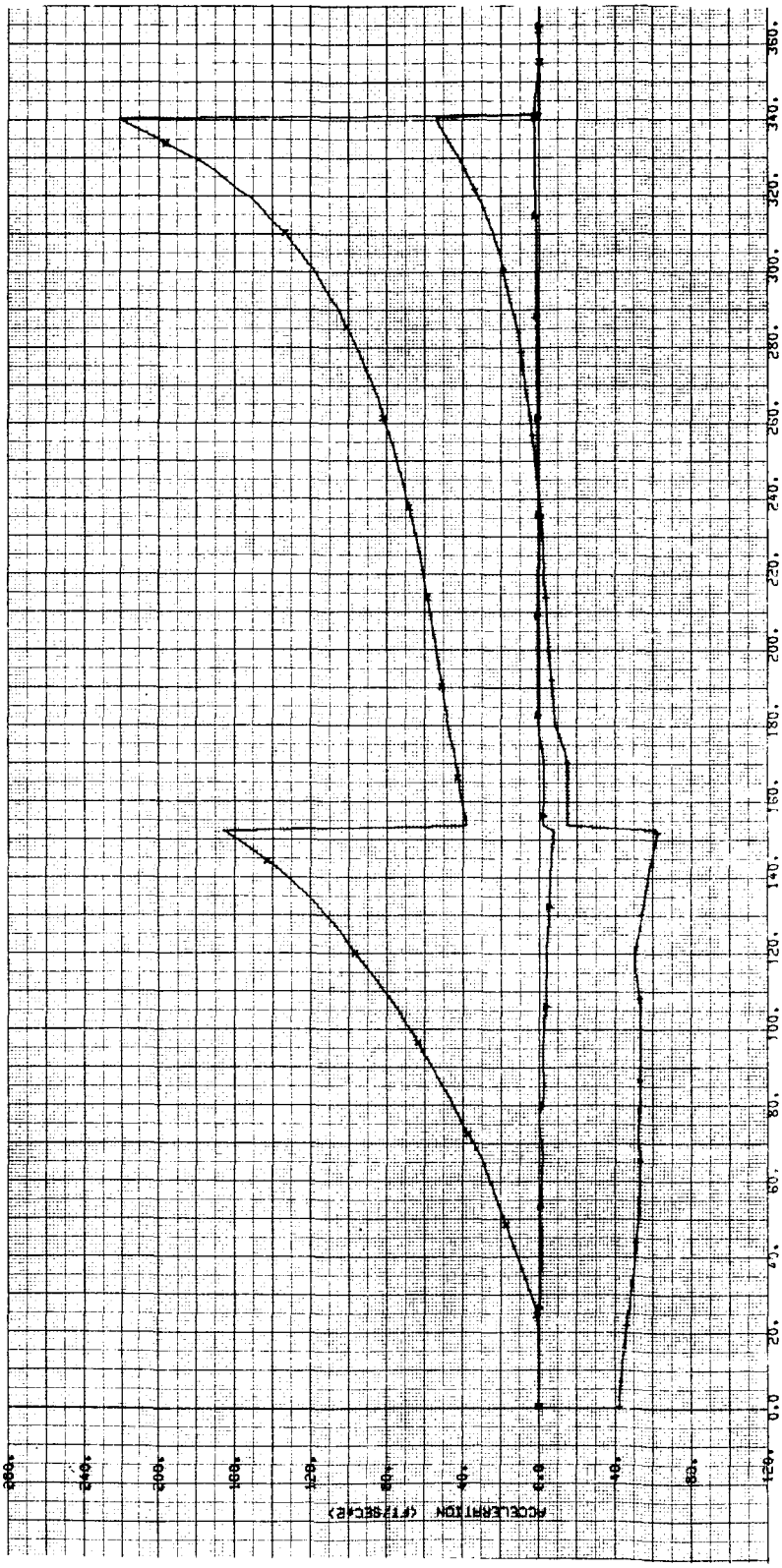

Figure A-1. Sensed Acceleration in Computer Coordinates - Ascent

Table A-1. Sensed Trajectory for the Ascent Flight Phase

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/S EC)	ZDOT (FT/SEC)	XDDOT (FT/SEC**2)	YDDOT (FT/SEC**2)	ZDDOT (FT/SEC**2)
.484	-	-027	-	-.06	-126.75	-.10	.02	-41.56	-.10
3.120		-706	-1	.06	-330.66	-.41	-.01	-42.12	-.18
5.233		-1259	-2	-.11	-525.55	-.91	-.00	-42.25	-.23
7.831	-	-2288	-5	-.19	-485.29	-1.59	.01	-42.76	-.29
9.947	-1	-2507	-6	.03	-527.05	-2.28	.03	-43.17	-.30
12.567	-	-4637	-16	.06	-660.60	-3.15	.03	-43.70	-.29
15.182	-	-6661	-26	.09	-755.67	-3.53	-.02	-44.23	-.30
17.307	-	-8367	-34	.11	-850.05	-4.34	-.07	-44.72	-.31
19.524	-	-10745	-47	-.24	-967.72	-5.34	-.03	-45.35	-.33
22.046	-1	-12902	-59	-.60	-1044.55	-6.02	.22	-45.91	-.39
24.569	-2	-15034	-75	.01	-1111.21	-6.86	1.06	-46.56	-.45
26.590	-	-16217	-90	2.41	-1276.01	-8.11	2.08	-47.11	-.53
29.249	16	-21372	-114	10.16	-1432.31	-9.63	3.17	-47.76	-.63
31.402	58	-25668	-142	22.48	-1529.05	-11.34	3.55	-48.44	-.75
33.930	116	-31267	-166	35.27	-1628.70	-12.88	6.00	-48.87	-.90
36.565	236	-33367	-204	55.79	-1755.35	-15.52	8.72	-49.47	-1.11
38.611	367	-37631	-233	74.77	-1851.55	-18.08	10.13	-49.67	-1.24
41.267	604	-42146	-270	104.24	-1963.11	-21.66	12.08	-50.41	-1.31
43.922	925	-47418	-319	138.19	-2117.71	-25.65	13.95	-50.57	-1.21
45.951	1237	-52041	-407	169.96	-2231.32	-27.73	15.42	-51.35	-1.09
48.605	1742	-58150	-484	212.17	-2356.67	-30.20	17.32	-51.65	-.97
50.632	2203	-63052	-546	246.68	-2474.00	-31.85	16.76	-52.22	-.96
53.290	2931	-69613	-635	301.79	-2613.96	-34.57	20.73	-52.65	-1.07
55.943	3813	-76530	-730	358.67	-2752.67	-37.56	22.76	-52.91	-1.16
57.971	4367	-82625	-802	406.32	-2861.54	-40.24	24.20	-53.05	-1.27
60.626	5233	-90405	-919	473.65	-3002.15	-43.20	25.95	-53.24	-1.59
62.653	6769	-96602	-1010	527.35	-3113.44	-46.62	27.40	-53.28	-1.74
65.311	9254	-105060	-1143	601.68	-3252.61	-52.63	29.46	-53.29	-1.98
67.963	9971	-113674	-1298	682.67	-3393.84	-57.33	32.24	-53.04	-1.78
69.990	11423	-120649	-1409	750.53	-3501.05	-61.65	34.56	-52.80	-1.15
72.644	13543	-130162	-1576	846.47	-3640.39	-64.72	37.71	-52.52	-.29
74.674	15338	-137628	-1708	925.55	-3746.59	-62.41	39.03	-52.47	-.01
77.331	17543	-147978	-1871	1036.16	-3865.74	-60.66	42.60	-52.62	-.39
79.986	20046	-158476	-2039	1152.30	-4006.15	-63.74	46.02	-52.68	-1.74
82.015	22472	-166756	-2169	1245.19	-4134.02	-69.76	46.66	-53.23	-2.49
84.670	26752	-177625	-2364	1373.14	-4275.84	-77.62	49.67	-53.29	-2.75
86.696	29635	-186657	-2527	1476.22	-4394.07	-82.55	52.24	-53.31	-2.69
89.357	33259	-195847	-2756	1614.98	-4525.31	-88.24	54.38	-53.52	-2.06
91.381	37143	-202716	-2939	1734.35	-4632.60	-93.22	57.65	-53.41	-2.02
94.042	41953	-220337	-3191	1891.46	-4775.76	-97.36	60.65	-53.60	-2.17
96.656	47212	-232203	-3458	2056.67	-4918.20	-103.66	63.34	-53.67	-2.48
98.726	51518	-243254	-3674	2188.23	-5027.59	-109.28	66.16	-53.67	-2.71
101.420	57658	-257035	-3978	2371.13	-5172.05	-116.59	69.56	-53.55	-2.96
103.446	62607	-267625	-4220	2514.56	-5280.44	-122.87	72.15	-53.44	-3.18
106.124	69604	-281056	-4561	2712.63	-5423.14	-131.69	75.67	-53.28	-3.51
108.201	75403	-293336	-4842	2872.00	-5534.13	-139.46	78.58	-52.57	-3.63
110.861	83322	-306624C	-5227	3085.85	-5674.76	-149.68	82.42	-52.42	-3.75
113.515	91808	-322486	-5627	3310.08	-5812.79	-159.16	86.48	-51.64	-3.81
115.545	98709	-335954	-5966	3466.68	-5916.93	-167.13	89.66	-50.99	-3.84
118.201	109256	-353178C	-6426	3732.24	-6051.59	-177.65	93.77	-50.48	-3.93
120.232	116670	-366075	-6755	3926.17	-6152.65	-185.45	96.86	-50.59	-4.06
122.528	127013	-390481	-7395	4162.27	-6268.44	-196.17	100.70	-51.26	-4.42
125.584	138510	-397337	-7845	4465.01	-6426.54	-208.57	104.51	-52.44	-4.90
127.616	147601	-410506	-8251	4680.09	-6534.36	-217.55	107.67	-53.25	-5.20
130.274	160622	-429060	-8883	4971.46	-6677.49	-233.72	112.20	-54.17	-5.35
132.305	170554	-443735	-9369	5202.63	-6781.59	-244.62	115.65	-54.76	-5.42
134.964	185205	-456580	-10079	5517.82	-6934.71	-258.81	121.15	-55.54	-5.62
136.991	196643	-474153	-10574	5767.19	-7047.68	-270.56	125.49	-56.24	-5.81
139.654	212446	-493115	-11316	6106.09	-7198.47	-286.53	131.29	-57.11	-6.04
142.348	229366	-512715	-12110	6469.66	-7353.73	-303.06	137.71	-58.07	-6.22
144.377	242803	-527762	-12738	6754.28	-7472.30	-315.60	143.08	-58.86	-6.38
147.105	261765	-548363	-13623	7154.06	-7634.00	-333.35	150.65	-59.94	-6.70
149.135	276604	-563566	-14313	7465.60	-7756.70	-347.12	156.67	-60.79	-7.04
151.754	297620	-584826	-15262	7852.71	-7913.85	-366.41	164.56	-61.91	-7.47
152.362	301528	-588336	-15471	7926.63	-7955.07	-370.68	166.24	-62.15	-7.57
153.827	313263	-601904	-16015	8036.03	-7973.39	-372.97	38.41	-14.74	-2.07
156.486	334761	-622782	-17014	8134.34	-8012.80	-378.47	39.40	-14.74	-2.15
159.143	356529	-643556	-18027	8245.40	-8052.32	-384.15	40.35	-14.74	-2.22
161.212	373675	-660250	-18821	8326.16	-8082.53	-389.09	41.12	-14.67	-2.28
163.870	395568	-681827	-19868	8440.09	-8121.32	-395.15	41.97	-14.66	-2.35
166.385	417350	-702327	-20872	8547.13	-8158.19	-401.03	42.61	-14.75	-2.37
168.652	437155	-721183	-21802	8646.06	-8192.60	-406.72	43.28	-14.55	-2.42
170.489	452770	-736704	-22537	8724.42	-8219.91	-410.91	43.93	-14.51	-2.26
173.123	475901	-757608	-23624	8840.17	-8259.54	-417.54	44.91	-13.85	-1.61
175.769	499447	-776508	-24734	8960.83	-8295.32	-420.72	46.13	-12.01	-.67
177.616	516083	-754883	-25515	9047.28	-8314.96	-420.28	47.11	-10.84	-.01
180.324	540775	-811426	-26652	9176.66	-8335.76	-418.64	48.13	-8.58	.58
182.070	556131	-840230	-27398	9259.59	-8346.99	-416.82	48.97	-7.17	.66
184.919	583435	-855812	-29569	9401.16	-8377.55	-415.55	49.59	-7.74	.66
187.626	609085	-876534	-29691	9532.34	-8387.55	-413.82	50.40	-7.18	.67
190.332	635057	-901267	-30808	9673.51	-8416.25	-412.00	51.17	-6.66	.70
192.189	653046	-918953	-31569	9765.31	-8428.43	-410.84	51.80	-6.40	.71
194.892	679103	-943705	-32677	9910.50	-8445.03	-409.64	52.61	-5.55	.70
196.738	696555	-960314	-33432	10007.37	-8455.36	-408.49	53.24	-5.80	.68
199.441	725404	-987241	-34594	10152.55	-8470.90	-408.69	54.04	-5.25	.66
202.193	753481	-1001515	-35645	10303.02	-8495.12	-407.86	54.66	-4.55	.66
204.241	772622	-1017206	-36390	10409.08	-8493.97	-402.97	55.53	-4.76	.66
206.749	8C1004	-1040226	-37478	10556.65	-8506.53	-407.86	56.36	-4.42	.66
209.455	829773	-1066283	-38560	10710.40	-8513.55	-394.56	57.27	-4.04	.64
211.304	849676	-1079016	-39267	10818.94	-8525.35	-397.88	57.95	-3.62	.62
214.014	875203	-1102193	-40339	10975.16	-8535.11	-396.26	58.90	-3.49	.62
216.719	901106	-1125274	-41442	11145.77	-8544.25	-394.56	59.81	-3.03	.64
218.570	925819	-1141051	-42171	11241.16	-8549.79	-393.30	60.56	-2.62	.64
221.316	940394	-1164546	-43249	11414.91	-8557.37	-391.50	61.57	-2.55	.62
223.162	962113	-1180747	-43911	11527.16	-8561.07	-390.43	62.38	-2.41	.60
225.673	1013704	-1203566	-44827	11666.41	-8567.50	-388.53	63.39	-2.08	.59
228.375	1045457	-1227376	-46077	11872.56	-8573.20	-387.22	64.46	-1.81	.57
230.426	1069536	-1242610	-46759	11997.33	-8576.25	-386.15	65.39	-1.59	.56
233.139	1100300	-1265668	-47827	12171.03	-8580.41	-384.83	66.47	-1.29	.54

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Table A-1. Sensed Trajectory for the Ascent Flight Phase (Continued)

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)	XDOT (FT/SEC**2)	YDOT (FT/SEC**2)	ZDOT (FT/SEC**2)
235.849	1132536	-1285122	-44676	12352.76	-6583.33	-393.23	71.60	-.58	.55
237.101	1156537	-1305025	-46537	12476.83	-6594.53	-392.26	68.59	-.64	.56
240.415	1180455	-1324525	-50622	12668.68	-6586.19	-380.66	69.86	-.16	.60
243.183	1225562	-1352668	-51674	12761.84	-6566.66	-379.17	71.15	.40	.65
245.055	1250165	-1369161	-52342	12755.65	-6574.67	-377.64	72.19	.65	.70
247.352	1274031	-1391854	-53413	13155.35	-6581.49	-375.78	73.62	1.47	.78
249.660	1310911	-1407824	-54114	13333.67	-6576.42	-374.26	74.76	1.88	.82
252.401	1347631	-1431183	-55137	13540.56	-6572.43	-371.64	76.20	2.48	.89
255.133	1384716	-1454557	-56149	13750.68	-6564.58	-369.34	77.68	3.16	.92
257.009	1410755	-1470022	-56839	13869.40	-6556.50	-367.64	78.50	3.56	.95
259.740	1446106	-1494622	-57841	14115.23	-6548.13	-365.04	80.75	3.65	.95
261.647	1471650	-1510900	-58535	14270.03	-6538.16	-363.07	82.02	4.60	.95
264.384	1515830	-1533966	-59526	14496.33	-6524.65	-360.53	83.60	5.74	.96
267.118	1555464	-1556651	-60508	14727.49	-6507.77	-357.99	85.31	6.48	.97
268.588	1582161	-1572742	-61176	14882.20	-6495.06	-356.12	86.86	7.11	1.01
271.725	1624243	-1596668	-62147	15126.65	-6474.74	-353.36	88.86	7.76	1.02
273.590	1652617	-1612960	-62804	15285.77	-6461.45	-351.30	90.01	8.26	1.03
276.328	1694852	-1636952	-63752	15546.07	-6436.24	-349.64	92.02	8.92	1.05
279.063	1737700	-1660827	-64712	15802.27	-6411.46	-345.70	94.72	9.47	1.07
280.670	1766012	-1674652	-65305	15984.88	-6392.47	-343.57	96.71	10.04	1.09
283.709	1812164	-1697004	-66306	16253.17	-6364.26	-340.64	99.23	10.67	1.11
285.573	1842633	-1712576	-66995	16435.87	-6343.37	-339.60	101.30	11.60	1.12
288.312	1888055	-1735301	-67962	16720.25	-6310.00	-336.40	103.90	12.86	1.16
291.046	1934149	-1756052	-68775	17006.38	-6272.73	-332.30	106.36	14.42	1.24
292.869	1965337	-1773112	-69379	17204.95	-6244.30	-329.95	107.21	15.22	1.27
295.476	2010554	-1794552	-70234	17492.47	-6205.14	-326.52	112.34	16.52	1.32
298.081	2056514	-1815679	-71090	17788.56	-6160.49	-322.97	115.12	17.64	1.36
300.683	2103165	-1837042	-71916	18092.56	-6112.32	-317.61	118.58	18.93	1.42
302.503	2136214	-1851774	-72495	18311.34	-6074.52	-313.65	121.13	19.68	1.43
305.111	2184440	-1872771	-73316	18632.66	-6024.66	-312.94	125.70	20.65	1.47
307.715	2233428	-1893958	-74126	18964.65	-5969.36	-309.23	130.61	22.74	1.50
310.319	2283257	-1914268	-74926	19307.49	-5908.76	-305.24	133.55	23.80	1.58
312.102	2317961	-1928332	-75468	19549.22	-5865.19	-302.50	137.61	25.55	1.69
314.705	2369346	-1948759	-76251	19913.20	-5796.48	-297.19	142.45	27.62	1.81
317.314	2421657	-1968962	-77020	20290.41	-5721.66	-293.00	147.13	29.51	1.93
319.917	2475030	-1988963	-77777	20681.99	-5641.52	-287.84	152.60	31.60	2.10
321.738	2512335	-2002819	-78317	20965.32	-5581.54	-283.83	156.68	34.11	2.28
324.345	2568144	-2023468	-79026	21385.19	-5493.60	-277.56	165.05	36.67	2.41
326.949	2624407	-2043649	-79743	21822.86	-5391.36	-270.97	171.26	39.70	2.49
329.552	2681753	-2063551	-80440	22280.23	-5269.17	-264.54	179.10	41.38	2.51
331.336	2721834	-2077186	-80958	22656.03	-5211.92	-259.94	186.17	43.53	2.49
333.542	2781273	-2096521	-81577	23101.87	-5093.16	-253.56	176.70	46.65	2.52
336.544	2842170	-2116023	-82229	23624.18	-4970.12	-247.11	206.45	48.51	2.60
339.058	2902215	-2134185	-82842	24154.67	-4842.21	-240.48	215.37	52.26	2.67
340.532	2938061	-2145213	-83193	24477.26	-4763.37	-236.51	221.35	53.98	2.72
341.585	2963596	-2154046	-83442	24536.46	-4747.47	-235.51	2.76	.33	.10
343.715	3016170	-2155685	-83943	24545.64	-4745.42	-235.28	2.57	.38	.10
345.575	3061835	-2172237	-84380	24551.85	-4744.32	-234.97	2.40	.44	.10
348.185	3125912	-2189734	-84993	24556.59	-4743.35	-234.73	1.32	.25	.06
350.612	3185506	-2206156	-85562	24557.78	-4743.20	-234.66	.63	.14	.02
352.574	3233523	-2222127	-86117	24558.35	-4743.00	-234.72	.22	.07	-.02
355.331	3301415	-2238025	-86610	24558.72	-4742.92	-234.76	.10	.04	-.01
357.662	3359142	-2253673	-87222	24559.77	-4742.73	-234.90	.27	-.01	-.00
360.030	3417622	-2269768	-87774	24558.91	-4743.05	-234.76	.07	.04	-.01
363.004	3490852	-2287548	-88471	24559.23	-4742.93	-234.69	-.53	.03	-.02
364.762	3534022	-2301673	-88954	24559.13	-4742.98	-235.03	.06	.05	-.04
367.407	3597564	-2319451	-89506	24559.23	-4742.93	-234.97	.20	.06	-.08
370.142	3665149	-2337864	-90148	24559.46	-4742.88	-235.10	.03	.17	-.07
372.765	3729667	-2356600	-90767	24561.62	-4742.06	-235.60	.15	.13	-.07
374.530	3772576	-2369748	-91192	24560.79	-4742.20	-235.56	-.03	.09	-.03
377.121	3836566	-2386456	-91782	24560.83	-4742.00	-235.60	-.06	.00	-.00
379.712	3900225	-2403415	-92403	24560.63	-4741.95	-235.54	-.10	.04	-.00
382.327	3964434	-2420043	-93039	24560.82	-4741.70	-235.67	-.04	.02	-.02
384.051	4007151	-2431434	-93436	24560.79	-4742.05	-235.54	-.02	.07	-.02
386.685	4071455	-2446440	-94046	24560.63	-4741.85	-235.86	.24	.00	-.02
389.273	4135015	-2461668	-94656	24560.87	-4741.96	-235.71	-.03	.00	.01
391.896	4199607	-2476263	-95265	24560.61	-4741.87	-235.79	.05	-.02	.03
393.607	4241460	-2486017	-95679	24560.67	-4742.21	-235.52	.16	-.14	-.00
396.188	4304619	-2501469	-96265	24560.90	-4742.01	-235.66	.28	-.05	-.00
398.767	4368159	-2516977	-96893	24560.75	-4742.02	-235.70	-.00	.00	-.00
401.386	4432006	-2532464	-97500	24560.70	-4742.13	-235.64	.10	.02	.00
403.543	4485319	-2545573	-98113	24560.74	-4742.16	-235.68	.04	.05	.03
405.667	4537422	-2557905	-98726	24560.80	-4741.97	-235.64	.07	.03	-.01
408.281	4601139	-2573526	-99335	24561.60	-4741.77	-235.49	.15	.10	-.01
410.883	4665283	-2588624	-99942	24561.54	-4741.36	-235.71	.02	.15	-.00
413.442	4728639	-2603613	-100551	24560.30	-4741.16	-235.57	.05	.17	.01

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Table A-2. Reconstructed Ascent Trajectory, ECI Coordinates

GEMINI 10 ASCENT RET

TIME	PX	PY	PZ	VX	VY	VZ	AX	AY	AZ
.4836	3024913.8	-18152574.7	9927932.1	1324.215	216.820	1.945	1.4128	-8.4822	4.6026
3.1203	3028610.3	-18151831.5	9927952.7	1327.887	195.022	13.713	1.3977	-8.6606	4.6160
5.2326	3031218.2	-18151438.7	9927991.9	1330.666	176.680	23.333	1.4246	-8.8312	4.6468
7.8313	3034681.7	-18151009.5	9928068.2	1334.351	153.263	39.566	1.4752	-9.2697	4.8225
9.9475	3037508.1	-18150706.7	9928154.5	1337.792	133.012	46.012	1.5689	-9.6296	5.0097
12.5666	3041017.3	-18150391.7	9928292.1	1341.910	107.294	59.292	1.6405	-10.0827	5.2689
15.1819	3044532.3	-18150146.2	9928465.6	1346.250	80.296	73.489	1.6628	-10.5570	5.5185
17.3069	3047397.0	-18149999.5	9928634.6	1349.919	57.474	85.566	1.6845	-10.9872	5.7441
19.9240	3050935.7	-18149887.5	9928878.1	1354.225	27.961	100.729	1.8036	-11.5418	6.0259
22.0461	3053813.2	-18149854.5	9929105.6	1357.821	2.938	113.815	2.1254	-12.0277	6.2223
24.5686	3057244.8	-18149885.7	9929413.4	1363.308	-28.092	130.104	3.0386	-12.5633	6.4214
26.5901	3060036.7	-18149968.7	9929689.4	1369.756	-54.188	143.066	4.1322	-12.9287	6.5100
29.2492	3063665.7	-18150159.5	9930093.1	1382.977	-89.313	160.588	5.8959	-13.3769	6.5944
31.9016	3067356.3	-18150443.5	9930542.1	1400.882	-125.103	178.145	7.7435	-13.7909	6.6468
33.9299	3070214.8	-18150726.0	9930917.5	1418.136	-153.656	191.876	9.1342	-14.0841	6.6069
35.5852	3072614.4	-18151184.4	9931450.6	1444.567	-191.767	209.443	11.0053	-14.4998	6.5660
38.6106	3076963.5	-18151602.7	9931987.7	1468.682	-221.191	222.326	12.4606	-14.7694	6.5034
41.2669	3080909.3	-18152243.2	9932501.4	1503.737	-261.238	239.656	14.4595	-15.0371	6.5243
43.9221	3084955.1	-18152980.5	9933160.7	1544.624	-301.636	257.036	16.4127	-15.2516	6.7150
45.9514	3088126.7	-18153634.0	9933695.9	1579.812	-332.623	270.580	17.8957	-15.3603	6.8789
48.6078	3092385.4	-18154572.2	9934439.6	1629.366	-373.832	289.455	19.8428	-15.5174	7.0547
50.6323	3095725.5	-18155361.0	9935040.4	1670.946	-405.362	304.093	21.3118	-15.6805	7.1132
53.2902	3100245.0	-18156494.0	9935873.7	1730.272	-447.254	322.901	23.3148	-15.8824	7.0490
55.9426	3104918.0	-18157736.5	9936755.1	1796.384	-489.968	341.613	25.3560	-15.9182	6.9218
57.9709	3108610.6	-18158764.0	9937462.1	1847.373	-522.790	355.511	26.7975	-15.9705	6.7855
60.6262	3113614.1	-18160207.0	9938430.1	1921.666	-564.403	373.470	28.5778	-16.0571	6.6270
62.6526	3117567.2	-18161383.7	9939200.4	1980.343	-597.374	386.455	29.9745	-16.0113	6.1860
65.3108	3122938.0	-18163030.5	9940247.5	2061.615	-641.077	401.668	32.0265	-15.9024	5.8005
67.9631	3128520.6	-18164785.7	9941334.4	2149.238	-682.434	417.304	34.7148	-15.2752	5.6159
69.9904	3132990.4	-18166201.0	9942191.1	2221.641	-713.523	427.892	36.9806	-14.5034	5.8509
72.6477	3138987.4	-18168148.7	9943346.2	2323.742	-751.294	442.830	40.0682	-13.4803	6.1970
74.6740	3143780.2	-18169697.0	9944258.6	2407.475	-776.730	457.556	42.2556	-13.0599	6.2267
77.3313	3150331.0	-18171803.7	9945498.5	2524.027	-809.565	474.980	44.9026	-13.0739	5.7375
79.9856	3157190.4	-18174000.0	9946778.1	2646.184	-845.623	488.574	47.3190	-13.7704	4.5144
82.0149	3162659.5	-18175745.0	9947778.1	2743.636	-874.497	496.514	49.2457	-14.1293	3.8094
84.6701	3170120.7	-18178119.2	9949106.6	2877.498	-913.403	504.524	52.1196	-13.9862	3.3697
86.6965	3176059.5	-18179999.0	9950136.4	2985.038	-941.576	511.655	54.4709	-13.6122	3.3979
89.3567	3184197.3	-18182550.2	9951538.7	3134.442	-976.528	520.650	57.5785	-13.0631	3.5055
91.3811	3190662.1	-18184553.7	9952570.9	3253.225	-1002.719	528.424	59.8703	-12.8582	3.3851
94.0422	3199534.9	-18187267.0	9953989.1	3416.401	-1036.540	537.321	62.8054	-12.7671	3.0825
96.6965	3208827.2	-18190063.2	9955425.7	3586.665	-1070.577	544.888	65.8535	-12.6360	2.5865
98.7258	3216242.5	-18192262.7	9956536.4	3722.424	-1096.711	549.660	68.2621	-12.4771	2.1763
101.4201	3226523.7	-18195262.2	9958025.1	3910.686	-1129.823	555.084	71.5904	-12.1107	1.6035
103.4465	3234596.5	-18197576.7	9959153.0	4058.042	-1154.252	557.857	74.0997	-11.8405	1.1411
106.1242	3245733.0	-18200708.7	9960650.1	4261.017	-1185.324	560.087	77.5331	-11.4698	.4765
108.2114	3254752.0	-18203196.0	9961814.2	4426.140	-1209.531	560.643	80.3648	-10.9268	-.0343
110.8606	3266804.6	-18206452.0	9963304.1	4642.473	-1238.469	559.682	84.0622	-10.0818	-.7330
113.5149	3279427.7	-18209773.0	9964786.9	4870.034	-1263.434	557.112	87.9518	-8.9830	-1.5091
115.5451	3289499.5	-18212356.0	9965914.4	5051.937	-1280.987	553.294	90.9827	-8.0824	-2.1168
118.2114	3303243.8	-18215787.0	9967375.6	5298.853	-1301.449	546.586	94.9613	-7.2251	-2.7934
120.2317	3314199.5	-18218442.7	9968478.9	5494.636	-1314.570	540.155	98.0148	-7.0370	-3.1249
122.9279	3329375.7	-18222010.2	9969923.2	5764.131	-1332.372	531.197	101.8870	-7.3725	-3.4435
125.5842	3345050.2	-18225576.7	9971322.5	6039.460	-1353.561	522.064	105.7986	-8.2013	-3.6229
127.6164	3357543.8	-18228345.7	9972379.4	6257.134	-1371.553	514.183	109.0225	-8.7319	-3.7535
130.2736	3374559.5	-18232022.5	9973728.6	6552.053	-1395.784	504.209	113.6107	-9.0661	-3.8578
132.3049	3388104.7	-18234876.5	9974744.6	6786.125	-1414.220	496.256	117.3873	-9.1891	-3.9565
134.9841	3406571.1	-18238670.0	9976051.1	7104.815	-1439.015	486.000	122.6204	-9.3828	-4.2038
136.9914	3421229.1	-18241606.7	9977027.4	7356.969	-1458.209	477.063	126.9872	-9.5936	-4.4116
139.6535	3441269.4	-18245523.2	9978281.2	7701.672	-1484.312	464.862	132.8214	-9.8163	-4.6993
142.3479	3462509.1	-18249559.0	9979516.5	8067.385	-1511.326	451.999	139.2778	-10.0124	-4.9512
144.3772	3479170.0	-18252646.5	9980423.7	8354.816	-1531.773	442.020	144.6876	-10.1693	-5.1801
147.1047	3502504.1	-18256862.7	9981609.6	8758.696	-1559.860	427.422	152.2932	-10.4090	-5.6629
149.1350	3520604.0	-18260091.2	9982465.9	9073.411	-1581.330	415.955	158.3425	-10.6333	-6.0091
151.7942	3545300.3	-18264294.5	9983550.4	9504.709	-1610.145	399.380	166.2644	-10.9277	-6.5406
153.3620	3550724.5	-18265210.5	9983776.1	9599.540	-1616.400	395.659	167.9559	-10.9906	-6.6541
153.8274	3564822.3	-18267557.2	9984341.6	9648.734	-1588.929	376.394	34.7577	17.9569	-13.1420
156.4856	3590594.3	-18271717.7	9985295.9	9742.269	-1541.348	341.531	35.6998	18.0078	-13.2801
159.1428	3616609.0	-18275750.5	9986157.1	9838.466	-1493.725	306.367	36.6412	18.0587	-13.4182
161.2121	3637046.9	-18278802.7	9986761.9	9914.969	-1456.241	278.139	37.3349	18.1493	-13.5522
163.8703	3663536.2	-18282609.2	9987453.1	10015.517	-1407.728	241.950	38.1375	18.1839	-13.6668
164.3849	3668882.5	-18283096.7	9988019.1	10112.420	-1361.753	207.465	38.7516	18.1587	-13.6881
168.6916	3712272.0	-18289184.7	9988460.4	10202.462	-1320.430	175.936	39.4091	18.0208	-13.6862
170.4895	3730678.6	-18291529.5	9988755.0	10273.871	-1288.237	151.603	40.0840	18.1980	-13.6189
173.1233	3757877.0	-18294861.2	9989106.2	10379.928	-1241.107	115.379	40.8280	19.3150	-13.6198
175.7688	3785480.6	-18298077.0	9989364.2	10488.954	-1187.976	79.673	41.7550	21.6854	-13.7658
177.6164	3804932.5	-18300232.7	9989488.4	10566.955	-1145.034	54.507	42.5477	23.1102	-13.8291
180.3264	3833725.7	-18303245.9	9989584.5	10683.271	-1077.674	16.269	43.2612	25.1010	-14.2686
183.0695	3863195.2	-18306105.2	9989574.9	10802.912	-1007.369	-23.446	43.9397	25.9073	-14.6478
184.9192	3883251.9	-18307924.0	9989506.4	10884.709	-959.011	-50.725	44.4624	26.3382	-14.8946
187.6281	3912901.9	-18310424.5	9989313.7	11005.807	-886.864	-91.600	45.1522	26.9016	-15.2075
190.3322	3942828.7	-18312723.7	9989010.0	11128.996	-813.427	-133.137	45.7963	27.4331	-15.4864
192.1928	3963502.9	-18314182.0	9988737.1	11214.387	-762.474	-161.835	46.3556	27.7133	-15.6468
194.8918	3994052.8	-18316145.0	9988241.1	11340.654	-686.708	-204.523	47.0635	28.1346	-15.9074
196.7385	4015075.1	-18317365.2	9987836.2	11428.212	-634.659	-234.092	47.6268	28.3684	-16.0625
199.4475	4046210.3	-18318979.7	9987142.7	11558.015	-557.194	-278.020	48.3206	28.7942	-16.3409
202.1926	4078121.2	-18320400.5	9986317.7	11691.627	-477.698	-323.165	49.0329	29.1855	-16.5725
204.0412	4099818.9	-18321233.5	9985691.9	11782.820	-423.392	-353.968	49.6408	29.4404	-16.7297
206.7492	4131909.8	-18322272.0	9984671.7	11918.296	-343.366	-399.559	50.4013	29.8113	-16.9598
209.4553	4164346.8	-18323091.5	9983528.2	12055.678	-262.125	-445.456	51.1751	30.2054	-17.2211
211.3039	4186721.0	-18323524.5	9982675.0	12150.784	-206.260	-477.429	51.8263	30.4607	-17.3907
214.0139	4219840.2	-18323971.0	9981316.2	12292.225	-123.189	-525.159	52.6280	30.8236	-17.6166
216.7190	4253285.3	-18324191.2	9979831.1	12435.754	-39.466	-572.995	53.4182	31.3179	-17.8813
218.5695	4276390.6	-18324210.7	9978740.1	12535.266	18.619	-606.095	54.1224	31.4834	-17.9901
221.3156	4317019.0	-18324040.5	9977907.9	12685.177	105.555	-655.758	55.0238	31.8614	-18.2507
223.1623	4334539.4	-18323791.0	9975765.6	12787.246	164.602	-689.644	55.7696	32.0816	-18.4127
225.8733	4369409.5	-18323226.7	9973827.9	12939.485	252.005	-739.983	56.6602	32.4553	-18.6509
228.5793	4404633.4	-18322425.5	9971757.1	13094.258	340.259	-790.583	57.6664	32.7877	-18.8805
230.4279	4428938.6	-18321740.2	9970263.4	13201.341	401.141	-825.629	58.4995	33.0655	-19.0655
233.1389	4464942.7	-18320531.7	9967954.7	13361.258	490.880	-877.622	59.4836	33.4142	-19.3027
235.8488	4501370.9	-18319078.0	9965505.4	13523.392	582.097	-930.196	60.5027	33.8212	-19.5383
237.7014	4525528.7	-18317941.5	9963748.6	13636.718	644.910	-966.547	61.4056	34.1939	-19.7580
240.4152	4563764.1	-18316065.0	9961052.7	13804.704	738.247	-1020.415	62.5456	34.7572	-20.0599
243.1828	4602211.0	-18313888.2	9958151.0	13979.601	835.161	-1076.531	63.6832	35.3945	-20.3771
245.0549	4628493.9	-18312262.5	9956100.1	14099.664	901.991	-1114.674	64.6204	35.9153	-20.6337
247.7922	4667332.2	-18309658.2	9952971.0	14278.069	1001.138	-1171.702	65.8903	36.6360	-20.9745
249.6634	4694121.6	-18307723.7	9950745.4	14402.056	1069.941	-1211.025	66.9277	37.1297	-21.2260
252.4006	4733830.2	-18304651.7	9947346.7	14587.061	1172.567	-1269.613	68.2106	37.8238	-21.5609
255.1330	4773953.2	-18301306.0	9943797.2	14775.161	1276.716	-1328.803	69.5292	38.5791	-21.9699

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Table A-2. Reconstructed Ascent Trajectory, ECI Coordinates (Continued)

GEMINI 10 ASCENT RET

TIME	PX	PY	PZ	VX	VY	VZ	AX	AY	AZ
257.0051	4801736.0	-18298848.0	9941270.7	14906.480	1349.428-1370.260		70.6349	39.0974	-22.2517
259.7494	4842776.1	-18295010.5	9937439.1	15101.494	1457.066-1431.553		72.3713	39.5121	-22.5296
261.6467	4871695.0	-18292159.7	9934668.9	15240.040	1533.912-1475.161		73.4383	40.5589	-23.1289
264.3840	4913687.7	-18287808.2	9930543.6	15442.593	1645.928-1539.176		74.8262	41.4493	-23.6532
267.1194	4956195.6	-18283151.7	9926245.7	15649.469	1760.484-1604.601		76.3562	42.2780	-24.1365
268.9875	4985580.6	-18279786.7	9923204.2	15793.280	1840.130-1650.002		77.7526	42.9998	-24.5262
271.7248	5029105.1	-18274587.7	9918595.0	16008.557	1959.072-1717.854		79.5828	43.8081	-25.0010
273.5900	5059103.9	-18270856.7	9915347.2	16158.179	2041.448-1764.699		81.1998	44.4093	-25.3655
276.3283	5103655.4	-18265099.7	9910419.4	16382.503	2163.657-1834.694		83.0451	45.1193	-25.7786
279.0527	5149764.1	-18259614.5	9905306.1	16612.325	2287.780-1905.567		84.9737	45.9161	-26.2490
280.9699	5180503.4	-18254567.2	9901623.9	16776.189	2375.953-1955.871		86.8112	46.6338	-26.6692
283.7092	5226886.0	-18247882.7	9896165.5	17017.058	2505.002-2029.749		89.1107	47.7165	-27.3009
285.5734	5258766.1	-18243129.7	9892333.9	17186.744	2594.472-2080.976		91.0712	48.6749	-27.8683
288.3127	5306182.7	-18235839.7	9886529.0	17436.617	2728.998-2157.847		93.3520	49.9110	-28.5623
291.0461	5354196.9	-18228191.7	9880522.6	17695.435	2867.474-2237.191		95.4986	51.3474	-29.4296
293.8693	5386619.6	-18222877.7	9876394.7	17872.089	2961.899-2291.075		98.1515	52.5716	-30.0229
295.4758	5433537.1	-18214978.2	9870320.7	18130.448	3100.500-2370.056		100.9981	54.0630	-30.8665
298.0813	5481120.7	-18206714.7	9864040.4	18390.626	3243.120-2451.360		103.5299	55.3647	-31.5882
300.6828	5529334.1	-18198089.0	9857554.6	18670.027	3389.013-2534.869		106.7127	56.7987	-32.4135
302.5031	5563498.1	-18191824.7	9852886.5	18866.946	3493.746-2594.229		109.7566	57.8811	-33.0697
305.1106	5613067.2	-18182517.0	9846009.1	19156.396	3646.375-2681.446		113.4161	59.4497	-34.0101
307.7150	5663347.4	-18173816.7	9838308.9	19455.650	3803.052-2771.152		117.2659	61.4986	-35.1805
310.3185	5714401.1	-18162707.2	9831575.2	19765.201	3963.957-2863.142		120.5520	62.8418	-35.9223
312.1019	5749840.4	-18155538.0	9826412.0	19983.531	4077.325-2928.041		124.5599	64.9358	-37.0532
314.7092	5802371.6	-18144684.5	9818651.0	20312.124	4249.904-3025.577		129.1791	67.3228	-38.3503
317.3137	5855715.4	-18133387.7	9810639.9	20652.924	4426.980-3126.913		132.9739	69.4798	-39.5008
319.9172	5909943.2	-18121623.0	9802362.9	21006.879	4611.923-3231.964		138.2624	72.2760	-40.9921
321.7375	5948814.4	-18113106.7	9796411.1	21263.110	4745.733-3307.656		143.6110	74.9371	-42.3897
324.3449	6004347.9	-18100474.5	9787441.1	21642.989	4944.652-3419.826		149.5401	77.7199	-43.9300
326.0494	6041229.4	-18093330.5	9778584.6	22039.558	5150.265-3535.596		155.2363	80.4321	-45.4872
329.5520	6119123.9	-18073650.0	9769225.9	22454.325	5364.283-3656.997		162.5347	83.6474	-47.4252
331.3361	6159448.7	-18063944.5	9762625.1	22750.022	5516.127-3742.817		169.7494	86.3773	-49.1397
333.9416	6219304.4	-18049274.0	9752703.5	23200.531	5746.106-3873.746		179.0429	90.2247	-51.4642
336.5442	6280298.1	-18034612.7	9742446.9	23676.268	5983.378-4009.241		188.1961	93.8449	-53.6085
338.0578	6340419.7	-18018673.2	9732198.1	24160.308	6223.600-4146.366		197.0232	97.3409	-55.6792
340.5320	6376248.7	-18009390.7	9726024.1	24454.512	6368.573-4229.198		203.2024	99.3910	-56.8935
341.5961	6402153.6	-18002621.2	9721532.9	24506.375	6419.260-4257.209		-6.4444	26.3744	-14.2507
343.7150	6454242.4	-17588912.7	9712448.9	24495.659	6476.857-4288.400		-6.7285	26.3831	-14.2483
345.5754	6499803.0	-17576817.2	9704446.0	24484.475	6526.477-4315.083		-6.9771	26.3904	-14.2461
348.1848	6563667.4	-17559697.5	9693138.0	24464.678	6594.920-4351.997		-8.1004	26.0554	-14.0758
350.6115	6623011.1	-17543617.5	9682535.7	24442.984	6657.482-4385.837		-8.8547	25.8328	-13.9806
352.4738	6680727.1	-17527818.5	9672336.1	24421.125	6718.221-4418.776		-9.3320	25.6923	-13.9307
355.3313	6738271.8	-17911909.7	9661680.6	24398.845	6778.658-4451.537		-9.5348	25.6248	-13.8830
357.6818	6795596.6	-17895905.0	9651178.4	24376.130	6838.876-4484.273		-9.4368	25.5853	-13.8484
360.0305	6852820.5	-17879773.0	9640608.7	24353.427	6898.687-4516.463		-9.7236	25.5770	-13.8482

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Table A-3a. Reconstructed Ascent Trajectory, Special Parameters

GEMINI 10 TRW ASCENT SET 1

TIME FROM LIFTOFF (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
.484	1341.8	4.3	.182	90.004	4.0	28.507	-80.555
3.120	1342.2	29.5	1.261	90.015	48.5	28.507	-80.555
5.233	1342.5	50.6	2.160	90.034	132.7	28.507	-80.555
7.831	1343.6	77.5	3.307	90.060	298.7	28.507	-80.555
9.947	1345.2	100.7	4.294	90.088	487.2	28.507	-80.555
12.567	1347.5	130.2	5.544	90.122	789.2	28.507	-80.555
15.182	1350.6	161.2	6.855	90.148	1170.0	28.507	-80.555
17.307	1353.8	187.5	7.959	90.167	1540.0	28.507	-80.555
19.924	1358.2	221.2	9.370	90.207	2074.2	28.507	-80.555
22.046	1362.6	249.8	10.562	90.232	2573.7	28.507	-80.555
24.569	1369.8	285.5	12.028	90.264	3248.2	28.507	-80.555
26.590	1378.3	315.5	13.228	90.324	3855.2	28.507	-80.555
29.249	1395.1	356.5	14.798	90.415	4748.2	28.507	-80.555
31.992	1417.7	399.2	16.329	90.531	5748.5	28.507	-80.555
33.930	1439.3	433.9	17.492	90.641	6591.5	28.507	-80.555
36.585	1472.2	481.1	18.952	90.822	7800.2	28.507	-80.554
38.611	1501.2	518.5	20.000	90.990	8804.2	28.506	-80.554
41.267	1544.9	570.9	21.328	91.228	10232.0	28.506	-80.553
43.922	1594.6	626.2	22.550	91.472	11789.2	28.506	-80.552
45.951	1636.8	670.7	23.407	91.653	13069.0	28.506	-80.551
48.638	1696.6	732.3	24.463	91.860	14865.2	28.505	-80.550
50.632	1746.1	781.8	25.193	92.010	16328.0	28.505	-80.549
53.290	1816.1	850.1	26.054	92.227	18375.5	28.505	-80.546
55.943	1891.2	922.5	26.825	92.452	20564.5	28.504	-80.544
57.971	1952.5	980.7	27.337	92.635	22339.0	28.504	-80.541
60.626	2037.3	1059.6	27.880	92.850	24793.0	28.503	-80.538
62.653	2104.3	1122.4	28.267	93.044	26767.7	28.503	-80.535
65.311	2196.0	1208.1	28.690	93.340	29492.5	28.502	-80.530
67.963	2293.3	1297.4	28.980	93.576	32363.0	28.501	-80.525
69.990	2372.3	1369.3	29.116	93.774	34659.2	28.500	-80.521
72.648	2482.0	1467.9	29.178	93.954	37799.5	28.499	-80.515
74.674	2570.7	1547.0	29.148	93.969	40293.2	28.498	-80.509
77.331	2692.9	1656.2	29.036	94.023	43691.5	28.497	-80.501
79.986	2820.6	1772.3	28.916	94.189	47234.7	28.496	-80.493
82.015	2922.1	1865.3	28.805	94.370	50046.0	28.495	-80.485
84.670	3060.8	1993.2	28.630	94.645	53860.7	28.493	-80.475
86.696	3171.6	2095.6	28.461	94.806	56877.0	28.492	-80.466
89.357	3324.1	2236.7	28.179	94.988	60972.7	28.490	-80.454
91.381	3445.0	2349.3	27.956	95.096	64195.0	28.489	-80.444
94.042	3610.4	2504.0	27.635	95.243	68569.7	28.487	-80.429
96.696	3782.5	2666.0	27.305	95.398	73092.2	28.485	-80.413
98.726	3919.3	2795.4	27.042	95.522	76659.0	28.483	-80.400
101.420	4108.3	2974.5	26.666	95.674	81541.0	28.480	-80.382
103.446	4255.7	3114.8	26.379	95.793	85321.7	28.478	-80.367
106.124	4458.1	3308.0	25.960	95.946	90462.2	28.475	-80.346
108.201	4622.6	3463.7	25.643	96.069	94563.5	28.473	-80.328
110.861	4837.3	3671.8	25.211	96.219	99950.0	28.470	-80.304
113.515	5062.6	3888.3	24.744	96.349	105502.5	28.466	-80.279
115.545	5241.1	4060.3	24.373	96.449	109846.2	28.463	-80.258
118.201	5483.4	4294.3	23.872	96.573	115662.7	28.459	-80.229
120.232	5675.5	4480.0	23.475	96.658	120207.0	28.456	-80.206
122.929	5939.9	4736.6	22.971	96.767	126374.0	28.451	-80.173
125.584	6211.3	5001.3	22.529	96.885	132607.7	28.446	-80.138
127.616	6426.3	5211.6	22.214	96.983	137490.0	28.442	-80.110
130.274	6719.0	5497.7	21.826	97.101	144030.7	28.437	-80.072
132.305	6949.7	5725.3	21.538	97.186	149153.7	28.433	-80.041
134.964	7265.3	6035.9	21.180	97.289	156029.5	28.427	-79.998
136.991	7515.2	6282.2	20.915	97.370	161404.5	28.422	-79.964
139.654	7857.2	6619.6	20.582	97.473	168644.7	28.415	-79.916
142.348	8220.2	6978.3	20.261	97.572	176192.2	28.408	-79.865
144.377	8505.6	7260.7	20.027	97.642	182030.0	28.402	-79.825
147.105	8906.8	7657.9	19.723	97.737	190092.2	28.394	-79.768
149.135	9219.6	7967.0	19.505	97.805	196261.2	28.387	-79.724
151.794	9648.4	8393.3	19.228	97.897	204569.0	28.379	-79.663
152.362	9742.7	8486.9	19.171	97.917	206377.2	28.377	-79.649
153.827	9785.9	8528.0	18.967	97.944	211044.2	28.372	-79.614
156.486	9869.4	8607.8	18.611	97.998	219448.2	28.362	-79.550
159.143	9955.9	8690.9	18.260	98.053	227763.2	28.353	-79.485
161.212	10025.2	8757.4	17.986	98.098	234191.5	28.345	-79.434
163.870	10116.9	8845.7	17.639	98.154	242370.2	28.335	-79.367
166.389	10205.8	8931.6	17.315	98.208	250046.0	28.326	-79.304
168.692	10289.1	9012.1	17.029	98.258	257003.5	28.317	-79.245
170.489	10355.5	9076.5	16.809	98.296	262396.7	28.310	-79.198
173.123	10454.5	9172.6	16.493	98.354	270239.0	28.300	-79.129
175.769	10556.4	9271.3	16.156	98.392	278041.7	28.289	-79.060
177.616	10629.0	9341.6	15.897	98.404	283437.5	28.282	-79.010
180.326	10737.5	9446.6	15.501	98.416	291260.2	28.271	-78.937
183.070	10849.8	9555.4	15.098	98.428	299061.2	28.260	-78.862
184.919	10927.0	9630.3	14.826	98.437	304252.7	28.252	-78.811
187.628	11041.9	9741.8	14.428	98.450	311755.0	28.240	-78.735
190.332	11159.5	9856.2	14.032	98.464	319121.7	28.229	-78.658
192.183	11241.5	9936.1	13.764	98.474	324092.0	28.221	-78.605
194.892	11363.3	10054.8	13.373	98.489	331262.7	28.209	-78.526
196.739	11449.3	10137.8	13.110	98.500	336078.7	28.201	-78.472

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Table A-3a. Reconstructed Ascent Trajectory, Special Parameters (Continued)

GEMINI 10 TPM ASCENT RET 4

TIME FROM LIFTOFF (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
199.447	11574.8	10261.4	12.727	98.517	343037.7	28.189	-78.392
202.193	11736.9	10389.7	12.344	98.536	349950.5	28.176	-78.309
204.941	11795.8	10477.8	12.088	98.548	354547.2	28.167	-78.253
206.749	11930.0	10609.4	11.719	98.568	361160.2	28.155	-78.169
209.455	12066.8	10743.7	11.356	98.589	367640.5	28.142	-78.084
211.304	12162.0	10837.3	11.111	98.604	371994.0	28.133	-78.026
214.014	12304.1	10977.1	10.756	98.627	378267.5	28.120	-77.939
216.719	12440.1	11119.9	10.409	98.650	384401.7	28.107	-77.851
218.570	12550.0	11219.3	10.174	98.666	388524.7	28.097	-77.791
221.316	12702.6	11369.9	9.831	98.691	394532.2	28.083	-77.699
223.162	12817.0	11472.9	9.603	98.709	398498.0	28.074	-77.637
225.873	12963.1	11627.1	9.276	98.737	404211.7	28.060	-77.545
229.579	13122.6	11784.8	8.956	98.764	409788.7	28.046	-77.451
230.429	13233.3	11894.3	8.741	98.784	413525.7	28.036	-77.387
233.139	13393.1	12058.5	8.433	98.814	418900.2	28.021	-77.291
235.849	13569.4	12226.2	8.137	98.845	424147.7	28.006	-77.194
237.701	13686.2	12342.9	7.928	98.867	427663.0	27.996	-77.126
240.415	13862.1	12517.4	7.636	98.899	432708.2	27.980	-77.027
243.193	14045.9	12699.8	7.342	98.933	437725.0	27.964	-76.924
245.055	14172.5	12825.4	7.146	98.956	441044.2	27.953	-76.853
247.782	14361.1	13012.7	6.862	98.988	445788.7	27.937	-76.748
249.660	14492.5	13143.3	6.671	99.011	448953.2	27.926	-76.676
252.401	14689.2	13338.7	6.395	99.045	453494.5	27.909	-76.568
255.133	14880.7	13539.1	6.126	99.079	457873.5	27.892	-76.460
257.005	15030.1	13677.8	5.943	99.103	460805.7	27.880	-76.384
259.740	15230.1	13885.7	5.691	99.139	464979.7	27.862	-76.272
261.647	15388.0	14033.9	5.493	99.163	467810.7	27.850	-76.194
264.384	15606.3	14251.1	5.242	99.202	471767.5	27.832	-76.079
267.119	15829.8	14473.8	4.989	99.240	475575.7	27.813	-75.962
268.988	15995.7	14629.7	4.819	99.267	478104.2	27.801	-75.882
271.725	16219.4	14861.9	4.573	99.307	481693.2	27.782	-75.762
273.590	16382.1	15024.0	4.409	99.335	484060.2	27.768	-75.680
276.328	16626.4	15267.6	4.175	99.378	487422.0	27.749	-75.557
279.063	16877.2	15517.6	3.950	99.421	490646.2	27.729	-75.432
280.930	17056.3	15696.2	3.796	99.451	492817.2	27.714	-75.344
283.709	17319.9	15959.3	3.579	99.496	495823.2	27.694	-75.215
285.573	17503.8	16142.7	3.434	99.527	497794.2	27.679	-75.127
288.313	17786.4	16418.8	3.225	99.574	500576.2	27.658	-74.994
291.046	18065.5	16703.2	3.018	99.622	503223.7	27.636	-74.860
292.869	18260.3	16897.7	2.882	99.654	504912.7	27.621	-74.770
295.476	18545.8	17182.8	2.689	99.700	507222.0	27.599	-74.638
298.081	18840.6	17477.1	2.500	99.748	509403.7	27.577	-74.505
300.683	19143.8	17779.9	2.315	99.797	511456.0	27.555	-74.369
302.503	19362.5	17998.2	2.189	99.831	512816.7	27.539	-74.273
305.111	19684.0	18319.4	2.013	99.881	514659.0	27.515	-74.132
307.715	20016.8	18651.8	1.844	99.934	516374.2	27.491	-73.990
310.319	20361.3	18996.0	1.683	99.986	517965.5	27.467	-73.845
312.102	20604.6	19239.1	1.578	100.024	518984.2	27.450	-73.745
314.700	20971.4	19605.6	1.409	100.077	520367.2	27.425	-73.595
317.314	21352.5	19986.4	1.249	100.132	521619.2	27.399	-73.443
319.917	21748.9	20382.6	1.092	100.188	522734.2	27.372	-73.288
321.738	22036.2	20669.8	.984	100.227	523441.2	27.353	-73.177
324.345	22462.8	21096.1	.837	100.283	524330.7	27.326	-73.017
326.949	22908.1	21541.2	.692	100.341	525081.5	27.297	-72.853
329.552	23374.3	22007.3	.539	100.401	525693.7	27.268	-72.686
331.336	23706.9	22339.7	.444	100.442	526034.0	27.248	-72.569
333.042	24213.7	22846.3	.308	100.506	526411.0	27.217	-72.396
336.544	24747.8	23380.4	.186	100.572	526653.5	27.196	-72.219
339.058	25291.5	23923.9	.072	100.637	526764.0	27.155	-72.044
340.532	25671.9	24254.3	.010	100.675	526770.7	27.136	-71.940
341.589	25688.7	24321.1	-.007	100.709	526754.5	27.123	-71.864
343.715	25698.2	24330.5	-.007	100.781	526720.7	27.095	-71.712
345.575	25704.5	24336.9	-.007	100.844	526690.7	27.071	-71.579
348.185	25709.4	24341.7	-.006	100.933	526649.5	27.037	-71.393
350.612	25710.6	24343.0	-.005	101.016	526612.0	27.006	-71.219
352.974	25711.3	24343.7	-.004	101.097	526576.2	26.974	-71.050
355.331	25711.6	24344.1	-.003	101.177	526541.2	26.943	-70.882
357.682	25711.7	24344.2	-.003	101.258	526506.7	26.911	-70.715
360.030	25711.8	24344.3	-.001	101.337	526473.5	26.880	-70.547
362.374	25712.2	24344.7	-.000	101.418	526432.5	26.839	-70.335
364.762	25712.1	24344.7	.001	101.498	526408.7	26.815	-70.210
367.497	25712.2	24344.7	.002	101.588	526374.5	26.778	-70.022
370.142	25712.4	24345.0	.003	101.680	526340.0	26.740	-69.828
372.769	25714.1	24346.8	.003	101.770	526307.2	26.704	-69.641
374.530	25713.9	24346.6	.004	101.829	526285.5	26.679	-69.516
377.121	25714.0	24346.7	.005	101.916	526254.7	26.642	-69.332
379.713	25713.9	24346.6	.005	102.003	526224.0	26.605	-69.148
382.327	25714.1	24346.8	.006	102.090	526193.7	26.567	-68.963
384.091	25714.0	24346.8	.008	102.149	526174.5	26.542	-68.838
386.685	25713.9	24346.8	.083	102.258	526190.2	26.504	-68.654
389.273	25713.7	24346.7	.159	102.365	526294.0	26.466	-68.471
391.854	25713.5	24346.6	.160	102.451	526441.5	26.427	-68.289
393.607	25713.4	24346.4	.162	102.509	526542.7	26.401	-68.165
396.188	25713.4	24346.5	.162	102.594	526692.7	26.363	-67.983

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Table A-3a. Reconstructed Ascent Trajectory, Special Parameters (Continued)

GEMINI 10 TPM ASCENT BET 7

TIME FROM LIFTOFF (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
398.767	25713.1	24346.2	.163	102.680	526843.7	26.324	-67.801
401.366	25712.9	24345.9	.165	102.765	526996.7	26.284	-67.618
403.963	25712.6	24345.9	.166	102.849	527149.7	26.245	-67.436
406.697	25712.6	24345.7	.166	102.907	527254.5	26.218	-67.312
408.281	25713.2	24346.3	.167	102.991	527409.2	26.178	-67.131
410.863	25715.0	24348.1	.168	103.076	527564.7	26.138	-66.949
413.442	25716.5	24349.7	.170	103.160	527722.0	26.097	-66.768

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Table A-3b. Reconstructed Ascent Trajectory, Special Parameters

GEMINI 10 TRW ASCENT BET

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
3.744	88.024	-131.101	-80.539	28.346	20909869.5
6.380	89.269	-168.861	-80.528	28.346	20909914.0
8.493	89.011	-158.141	-80.519	28.346	20909998.2
11.091	88.869	-158.947	-80.508	28.346	20910164.2
13.207	88.782	-165.773	-80.500	28.346	20910352.7
15.827	88.692	-165.745	-80.489	28.346	20910654.7
18.442	88.713	-164.984	-80.478	28.346	20911035.5
20.567	88.744	-164.171	-80.469	28.346	20911405.7
23.184	88.645	-160.180	-80.458	28.346	20911940.0
25.306	88.616	-156.707	-80.449	28.346	20912439.5
27.829	88.667	-160.507	-80.439	28.346	20913114.0
29.950	88.620	-176.457	-80.430	28.346	20913721.2
32.569	88.109	148.691	-80.419	28.346	20914614.2
35.162	86.830	127.170	-80.408	28.346	20915614.5
37.190	85.515	118.716	-80.399	28.346	20916457.5
39.845	83.558	113.167	-80.388	28.346	20917666.5
41.871	81.999	110.806	-80.379	28.345	20918670.5
44.527	79.809	108.620	-80.367	28.345	20920098.5
47.182	77.557	106.982	-80.355	28.345	20921656.0
49.211	75.806	105.885	-80.346	28.345	20922936.0
51.868	73.607	104.561	-80.333	28.344	20924732.5
53.892	71.936	103.696	-80.323	28.344	20926195.7
56.550	69.764	102.874	-80.310	28.344	20928243.5
58.203	67.682	102.279	-80.296	28.343	20930433.0
61.231	66.101	101.932	-80.286	28.343	20932208.0
63.886	64.043	101.458	-80.271	28.342	20934662.7
65.913	62.604	101.291	-80.260	28.342	20936637.7
68.571	60.766	101.249	-80.244	28.341	20939363.5
71.223	58.914	101.028	-80.228	28.340	20942235.0
73.250	57.460	100.920	-80.215	28.339	20944531.7
75.908	55.521	100.591	-80.198	28.338	20947673.2
77.934	54.035	100.066	-80.184	28.337	20950167.7
80.591	52.106	99.549	-80.165	28.336	20953567.2
83.246	50.314	99.362	-80.145	28.335	20957111.7
85.275	49.012	99.359	-80.129	28.334	20959924.0
87.930	47.374	99.448	-80.10[illegible]	28.332	20963740.2
89.956	46.157	99.426	-80.090	28.331	20966757.7
92.617	44.570	99.356	-80.067	28.329	20970855.5
94.641	43.427	99.265	-80.048	28.328	20974079.2
97.302	41.573	99.175	-80.023	28.326	20978456.0
99.956	40.604	99.123	-79.996	28.324	20982980.7
101.986	39.602	99.105	-79.974	28.322	20986549.5
104.640	38.305	99.072	-79.944	28.319	20991434.0
106.706	37.362	99.064	-79.921	28.317	20995217.0
109.384	36.153	99.059	-79.889	28.314	21000360.5
111.461	35.262	99.071	-79.863	28.312	21004466.0
114.121	34.137	99.083	-79.828	28.309	21009863.0
116.775	33.022	99.075	-79.791	28.305	21015410.0
118.805	32.186	99.078	-79.762	28.302	21019756.7
121.461	31.115	99.078	-79.722	28.298	21025577.5
123.492	30.307	99.071	-79.690	28.295	21030125.0
126.188	29.302	99.064	-79.646	28.290	21036296.7
128.844	28.414	99.081	-79.600	28.285	21042535.5
130.976	27.787	99.109	-79.563	28.282	21047421.7
133.534	27.021	99.138	-79.514	28.276	21053968.0
135.565	26.464	99.157	-79.474	28.272	21059095.5
138.224	25.778	99.175	-79.420	28.266	21065977.5
140.251	25.280	99.196	-79.378	28.261	21071357.5
142.914	24.663	99.223	-79.319	28.254	21078604.5
145.608	24.075	99.249	-79.257	28.247	21086159.5
147.637	23.652	99.264	-79.208	28.241	21092003.0
150.365	23.110	99.289	-79.140	28.233	21100073.5
152.395	22.726	99.308	-79.087	28.227	21106249.0
155.054	22.246	99.337	-79.015	28.218	21114565.7
155.672	22.147	99.344	-78.999	28.216	21116376.0
157.087	21.890	99.366	-78.958	28.211	21121048.2
159.746	21.464	99.412	-78.882	28.202	21129461.7
162.403	21.035	99.458	-78.806	28.192	21137791.5
164.472	20.701	99.497	-78.746	28.185	21144222.2
167.130	20.277	99.544	-78.669	28.175	21152411.0
169.649	19.883	99.590	-78.595	28.166	21160096.5
171.952	19.533	99.633	-78.526	28.157	21167062.7
173.749	19.265	99.665	-78.472	28.150	21172463.0
176.383	18.879	99.714	-78.393	28.140	21180316.0
179.029	18.471	99.741	-78.312	28.129	21188129.2
180.876	18.159	99.742	-78.255	28.122	21193532.7
183.586	17.685	99.737	-78.170	28.111	21201366.7
186.330	17.203	99.732	-78.084	28.099	21209179.2
188.179	16.978	99.729	-78.025	28.092	21214378.5
190.888	16.404	99.727	-77.937	28.080	21221892.5
193.592	15.934	99.725	-77.849	28.069	21229271.0
195.443	15.616	99.724	-77.789	28.061	21234249.5
198.152	15.153	99.723	-77.699	28.049	21241432.2
199.998	14.841	99.724	-77.63[illegible]	28.041	21246256.5

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Table A-3b. Reconstructed Ascent Trajectory, Special Parameters (Continued)

GEMINI 10 TRW ASCENT BET

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
202.707	14.389	99.726	-77.545	28.029	21253227.7
205.453	13.937	99.729	-77.451	28.016	21260162.2
207.301	13.636	99.732	-77.386	28.008	21264758.7
210.009	13.203	99.737	-77.292	27.995	21271384.5
212.715	12.776	99.743	-77.196	27.982	21277877.7
214.564	12.490	99.749	-77.129	27.973	21282240.2
217.274	12.075	99.758	-77.031	27.960	21288527.2
219.979	11.669	99.768	-76.932	27.947	21294675.0
221.830	11.395	99.775	-76.864	27.938	21298807.2
224.576	10.997	99.787	-76.761	27.924	21304828.7
226.422	10.733	99.796	-76.691	27.914	21308804.2
229.133	10.353	99.811	-76.588	27.900	21314532.2
231.839	9.983	99.825	-76.483	27.886	21320123.7
233.688	9.734	99.837	-76.410	27.876	21323870.7
236.389	9.379	99.855	-76.303	27.862	21329260.2
239.100	9.030	99.873	-76.195	27.847	21334522.7
240.961	8.797	99.887	-76.120	27.836	21338048.5
243.675	8.462	99.907	-76.009	27.821	21343109.2
246.443	8.125	99.930	-75.894	27.805	21348142.2
248.315	7.901	99.943	-75.815	27.794	21351472.5
251.052	7.577	99.965	-75.699	27.778	21356233.5
252.920	7.360	99.980	-75.619	27.767	21359409.2
255.661	7.046	100.002	-75.500	27.750	21363957.5
258.393	6.740	100.025	-75.380	27.733	21368363.7
260.265	6.533	100.041	-75.297	27.721	21371307.7
263.000	6.237	100.065	-75.174	27.704	21375499.5
264.907	6.032	100.082	-75.087	27.691	21378343.0
267.644	5.742	100.109	-74.961	27.673	21382313.0
270.378	5.458	100.137	-74.833	27.655	21386144.7
272.248	5.267	100.157	-74.744	27.642	21388686.2
274.995	4.992	100.186	-74.613	27.623	21392294.2
276.850	4.808	100.206	-74.523	27.610	21394674.7
279.588	4.548	100.238	-74.388	27.590	21398056.0
282.323	4.296	100.271	-74.252	27.570	21401300.5
284.230	4.125	100.294	-74.156	27.556	21403485.7
286.960	3.884	100.328	-74.016	27.536	21406512.7
288.833	3.724	100.352	-73.920	27.521	21408498.0
291.573	3.493	100.389	-73.776	27.500	21411304.5
294.306	3.264	100.426	-73.631	27.478	21413971.0
296.129	3.115	100.451	-73.532	27.463	21415675.0
298.736	2.903	100.488	-73.390	27.442	21418005.7
301.341	2.695	100.526	-73.246	27.420	21420209.7
303.943	2.493	100.565	-73.099	27.397	21422284.5
305.769	2.355	100.592	-72.995	27.381	21423661.2
308.371	2.163	100.633	-72.844	27.358	21425526.7
310.975	1.979	100.675	-72.691	27.334	21427265.7
313.579	1.801	100.718	-72.535	27.310	21428881.2
315.362	1.681	100.748	-72.427	27.293	21429917.0
317.969	1.507	100.792	-72.266	27.268	21431325.5
320.574	1.335	100.837	-72.103	27.242	21432603.2
323.177	1.165	100.882	-71.937	27.215	21433748.7
324.968	1.049	100.914	-71.820	27.197	21434470.5
327.605	.883	100.960	-71.648	27.169	21435387.5
330.209	.726	101.007	-71.473	27.141	21436166.5
332.812	.572	101.056	-71.296	27.112	21436807.7
334.596	.471	101.090	-71.172	27.091	21437168.0
337.202	.326	101.143	-70.987	27.061	21437575.2
339.804	.197	101.199	-70.799	27.030	21437848.7
342.318	.076	101.252	-70.614	26.999	21437990.0
343.792	.010	101.285	-70.503	26.980	21438015.2
344.849	-.007	101.319	-70.423	26.967	21438012.2
346.975	-.008	101.395	-70.262	26.940	21438005.5
348.835	-.007	101.462	-70.122	26.916	21437999.2
351.445	-.007	101.556	-69.924	26.882	21437991.5
353.972	-.005	101.643	-69.741	26.850	21437985.5
356.234	-.005	101.729	-69.562	26.819	21437980.5
358.591	-.004	101.814	-69.384	26.788	21437976.5
360.942	-.003	101.899	-69.207	26.756	21437973.0
363.290	-.001	101.983	-69.029	26.725	21437971.0
366.264	-.000	102.090	-68.805	26.684	21437969.7
368.022	.001	102.154	-68.673	26.660	21437969.7
370.667	.002	102.248	-68.473	26.624	21437971.2
373.402	.003	102.346	-68.268	26.586	21437974.0
376.029	.003	102.441	-68.070	26.549	21437977.2
377.790	.004	102.504	-67.937	26.525	21437980.0
380.381	.005	102.596	-67.743	26.488	21437985.2
382.973	.005	102.688	-67.548	26.451	21437990.5
385.587	.007	102.781	-67.352	26.414	21437997.0
387.351	.008	102.843	-67.220	26.388	21438002.7
389.945	.008	102.958	-67.025	26.350	21438055.2
392.533	.168	103.072	-66.831	26.313	21438196.0
395.114	.169	103.163	-66.638	26.274	21438380.7
396.867	.171	103.224	-66.507	26.248	21438507.5
399.448	.171	103.314	-66.314	26.210	21438695.0

Table A-3b. Reconstructed Ascent Trajectory, Special Parameters (Continued)

GEMINI 10 TRW ASCENT BET 14

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
402.027	.173	103.405	-66.121	26.171	21438883.5
404.626	.174	103.495	-65.927	26.132	21439074.7
407.203	.175	103.584	-65.735	26.092	21439266.0
408.957	.175	103.646	-65.604	26.066	21439396.7
411.541	.177	103.735	-65.411	26.026	21439590.0
414.123	.178	103.825	-65.219	25.986	21439784.2
416.702	.180	103.914	-65.027	25.946	21439980.5

APPENDIX B

REENTRY TRAJECTORY

The reentry trajectory is provided in two sets, the earth-centered inertial coordinates and the special earth-referenced coordinates. The inertial set has the z axis aligned with the earth's rotational axis, positive north, and the x-y plane is in the equatorial plane with the x-z plane containing the Greenwich meridian at the time of retrofire (21 July 20^h 30^m 51.0^s).

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Table B-1. Reconstructed Reentry Trajectory, ECI Coordinates

GEMINI 10 ENTRY TRW BET V

EARTH CENTERED INERTIAL GREENWICH COORDINATE SYSTEM

TIME (SEC)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)
1323.3620	-2038678.66	-18586279.00	10225045.00	25785.19	-1461.56	930.14
1325.7900	-1976063.95	-18589748.25	10227259.50	25792.44	-1396.14	893.99
1328.1860	-1914257.27	-18593015.75	10229358.62	25799.21	-1331.21	858.21
1330.5820	-1852434.73	-18596127.75	10231371.87	25805.65	-1266.54	822.38
1332.9780	-1790596.00	-18599084.50	10233299.37	25812.09	-1201.52	786.45
1335.3730	-1728769.11	-18601884.50	10235146.12	25818.11	-1136.75	750.77
1337.7690	-1666956.81	-18604530.50	10236896.12	25824.12	-1071.80	714.96
1340.1640	-1605046.53	-18607019.75	10238565.37	25829.80	-1006.99	679.05
1344.5100	-1492768.59	-18611146.00	10241375.25	25839.65	-889.16	614.03
1347.3660	-1418961.69	-18613568.75	10243068.12	25845.53	-811.63	571.41
1349.3060	-1368817.33	-18615092.25	10244148.62	25849.62	-758.98	542.48
1352.1630	-1294957.45	-18617156.00	10245637.00	25854.98	-681.53	499.50
1354.1050	-1244743.81	-18618422.25	10246578.75	25858.73	-628.68	470.36
1356.9600	-1170909.95	-18620136.50	10247863.50	25863.56	-551.15	427.54
1358.9000	-1120731.47	-18621124.50	10248661.87	25866.77	-498.42	398.56
1361.7600	-1046746.44	-18622439.00	10249740.00	25871.28	-420.65	355.40
1363.6990	-996579.55	-18623203.25	10250401.12	25873.95	-367.90	326.43
1366.5560	-922651.17	-18624143.75	10251272.37	25878.04	-290.34	283.55
1368.4940	-872497.43	-18624655.50	10251793.62	25880.55	-237.76	254.28
1371.3540	-798474.42	-18625224.00	10252459.50	25884.03	-159.88	211.44
1373.2960	-748205.10	-18625483.00	10252841.75	25886.20	-106.93	182.16
1376.1600	-674063.52	-18625677.75	10253302.12	25888.96	-29.05	139.32
1378.1070	-623055.38	-18625582.75	10253544.75	25890.78	24.06	109.93
1380.9690	-549552.49	-18625502.50	10253797.62	25893.22	101.89	66.73
1382.9140	-499189.56	-18625252.75	10253899.00	25894.48	154.92	37.59
1385.7780	-425024.77	-18624697.25	10253944.87	25896.33	233.01	-5.57
1387.7220	-374681.05	-18624192.75	10253905.62	25897.62	285.94	-34.85
1390.5880	-300456.82	-18623261.00	10253743.87	25898.82	364.29	-77.95
1392.5340	-250056.80	-18622500.50	10253563.75	25899.38	417.30	-107.27
1394.4740	-199811.36	-18621639.50	10253327.37	25899.97	470.22	-136.36
1397.3460	-125426.50	-18620177.00	10252873.75	25900.45	548.37	-179.56
1399.2860	-75179.34	-18619361.75	10252497.00	25900.69	601.25	-208.81
1402.1610	-714.94	-18617220.25	10251834.37	25900.64	679.87	-252.17
1404.1010	49532.07	-18615850.00	10251316.75	25900.33	732.76	-281.44
1406.9720	123891.15	-18613633.75	10250446.62	25899.76	811.09	-324.74
1411.7850	248542.34	-18609414.25	10248709.00	25898.08	942.32	-397.32
1416.6020	373280.94	-18604558.75	10246620.37	25895.23	1073.67	-469.86
1418.5420	423522.59	-18602424.25	10245680.50	25894.04	1126.64	-499.08
1421.4170	497964.59	-18599472.25	10244183.25	25891.70	1205.34	-542.69
1423.3560	548166.96	-18596683.75	10243103.00	25890.14	1258.39	-571.70
1426.2300	622570.73	-18592355.25	10241397.37	25887.14	1336.58	-615.28
1428.1610	672556.50	-18590323.50	10240181.25	25884.77	1389.29	-644.27
1431.0340	746919.38	-18586219.50	10238267.75	25881.44	1467.59	-687.77
1432.9740	797126.66	-18583321.25	10236905.12	25878.88	1520.47	-717.05
1435.8490	871522.65	-18578837.00	10234780.87	25874.85	1599.00	-760.67
1437.7900	921742.45	-18575682.00	10233276.25	25872.02	1651.91	-789.76
1440.6640	996691.69	-18570821.75	10230944.00	25867.31	1730.21	-833.18
1442.6080	1046374.27	-18567407.00	10229295.75	25863.72	1783.04	-862.63
1445.4810	1120673.17	-18562172.00	10226755.00	25858.17	1861.14	-906.03
1447.4250	1170937.42	-18558502.50	10224965.00	25854.02	1914.07	-935.53
1450.3030	1245258.55	-18552887.00	10222213.25	25847.63	1992.31	-978.79
1452.2430	1295475.92	-18548964.75	10220283.00	25843.10	2045.05	-1007.99
1455.1170	1369738.58	-18542975.00	10217323.87	25835.98	2123.24	-1051.31
1457.0600	1419933.55	-18538798.25	10215252.87	25830.88	2176.06	-1080.37
1459.9330	1494133.86	-18532434.25	10212086.75	25822.92	2254.10	-1123.73
1461.8750	1544276.89	-18528005.50	10209876.00	25817.25	2306.82	-1152.91
1464.7480	1618436.53	-18521266.00	10206501.75	25808.24	2384.88	-1196.05
1466.6920	1668601.69	-18516578.50	10204148.50	25801.99	2437.59	-1225.03
1469.5650	1742716.44	-18509463.25	10200567.12	25792.24	2515.66	-1268.10
1471.5120	1792875.89	-18504519.25	10198072.37	25785.40	2568.13	-1297.16
1474.3940	1872380.23	-18496471.00	10194000.37	25773.59	2651.22	-1343.53
1476.3600	1928196.50	-18490665.25	10191054.87	25765.33	2709.55	-1376.25
1478.9720	1983891.84	-18484744.25	10188044.00	25756.30	2767.76	-1408.99
1481.0810	2039489.45	-18478706.00	10184966.62	25746.89	2825.82	-1441.77
1483.2420	2095117.37	-18472537.00	10181815.50	25737.08	2883.70	-1474.66
1486.4400	2177400.19	-18463179.00	10177021.12	25721.87	2969.24	-1521.70
1488.6066	2233101.59	-18456684.00	10173685.37	25710.34	3027.02	-1556.41
1490.7652	2288597.41	-18450086.50	10170289.75	25698.45	3084.72	-1589.15
1492.9260	2344118.62	-18443358.00	10166820.62	25686.05	3142.39	-1621.49
1496.1220	2426180.12	-18433179.75	10161561.50	25666.84	3227.07	-1669.57
1498.2850	2481682.62	-18426138.25	10157914.87	25653.22	3283.86	-1702.25
1500.4460	2537104.12	-18418980.75	10154221.25	25638.99	3340.33	-1734.74
1502.6080	2592519.41	-18411697.50	10150415.37	25624.27	3397.20	-1767.47
1504.7660	2647800.22	-18404305.25	10146565.75	25608.66	3453.83	-1800.25
1507.9680	2729759.87	-18393111.50	10140723.62	25584.20	3537.90	-1848.77
1510.1300	2785053.72	-18385401.75	10136691.62	25565.74	3594.12	-1881.09
1512.2890	2840232.37	-18377582.25	10132596.25	25548.36	3649.49	-1912.73
1514.4500	2895422.12	-18369636.25	10128428.75	25529.34	3704.58	-1944.23
1517.6480	2977017.53	-18357659.50	10122136.62	25499.72	3785.62	-1990.81
1519.8140	3032226.62	-18349400.00	10117790.50	25477.84	3840.70	-2022.24
1521.9690	3087106.87	-18341064.25	10113399.37	25455.13	3895.41	-2053.03
1524.1240	3141937.69	-18332611.25	10108942.62	25431.97	3949.58	-2083.15
1527.3140	3223009.19	-18319886.50	10102226.87	25396.51	4028.31	-2127.35
1529.4680	3277685.47	-18311152.50	10097612.50	25370.90	4081.52	-2157.09
1531.6250	3332381.06	-18302290.75	10092927.62	25343.28	4135.07	-2186.80
1533.7770	3386888.03	-18293335.50	10088190.12	25314.30	4187.78	-2216.11
1536.9490	3467115.87	-18279932.00	10081092.62	25270.76	4263.31	-2259.04

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Table B-1. Reconstructed Reentry Trajectory, ECI Coordinates (Continued)

GEMINI 10 ENTRY TRW BET V

EARTH CENTERED INERTIAL GREENWICH COORDINATE SYSTEM

TIME (SEC)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)
1539.0990	3521414.72	-18270710.75	10076235.25	25239.24	4314.60	-2287.22
1541.2460	3575566.31	-18261392.00	10071264.62	25205.36	4366.11	-2315.20
1543.3910	3629596.37	-18251973.00	10066268.25	25170.00	4416.23	-2343.36
1546.5650	3709398.84	-18237841.25	10058767.00	25116.67	4488.39	-2383.37
1548.7130	3763307.91	-18228147.00	10053619.00	25077.67	4537.94	-2409.92
1550.8610	3817131.16	-18218346.75	10048413.12	25036.93	4586.95	-2437.24
1553.0040	3870741.16	-18208466.50	10043161.87	24995.59	4634.10	-2463.62
1556.1770	3949951.28	-18193652.75	10035285.87	24932.42	4703.35	-2500.76
1558.3270	4003567.84	-18183490.75	10029879.75	24887.68	4749.56	-2528.10
1560.4750	4056914.53	-18173239.75	10024421.62	24839.81	4795.21	-2554.05
1562.6220	4110194.00	-18162896.00	10018912.75	24792.14	4840.34	-2577.61
1564.7640	4163245.59	-18152480.50	10013364.75	24742.55	4884.76	-2602.66
1567.9450	4241828.31	-18136837.75	10005028.75	24665.33	4950.26	-2638.42
1570.0880	4294628.50	-18126184.50	9999350.25	24610.98	4992.21	-2661.13
1572.2300	4347283.19	-18115446.50	9993625.12	24553.05	5033.82	-2684.52
1574.3730	4399835.50	-18104614.50	9987849.62	24492.41	5075.28	-2705.54
1577.5450	4477374.19	-18088427.25	9979217.25	24397.08	5131.16	-2737.30
1579.6960	4529776.50	-18077349.00	9973308.50	24326.59	5169.39	-2756.73
1581.8390	4581032.81	-18066234.00	9967379.00	24255.94	5203.94	-2777.10
1583.9840	4633781.19	-18055033.50	9961402.62	24181.03	5239.43	-2795.23
1587.1590	4710373.06	-18038319.75	9952484.87	24065.53	5288.83	-2822.26
1589.3060	4761953.62	-18026930.50	9946408.00	23983.37	5320.67	-2838.51
1591.4480	4813235.81	-18015500.25	9940309.75	23899.19	5351.74	-2855.50
1593.5940	4864432.12	-18003984.25	9934165.87	23814.17	5380.90	-2870.40
1596.7710	4939881.75	-17986820.75	9925010.00	23683.20	5423.87	-2893.45
1598.9200	4990680.25	-17975136.50	9918776.50	23593.51	5450.47	-2907.85
1601.0630	5041141.19	-17963426.50	9912529.50	23500.11	5478.05	-2922.28
1603.2010	5091284.81	-17951687.25	9906268.87	23406.89	5503.38	-2934.24
1606.3730	5165302.94	-17934171.25	9896931.37	23262.83	5540.86	-2953.23
1608.5190	5215119.37	-17922257.00	9890580.25	23164.53	5562.79	-2965.83
1610.6570	5264534.75	-17910338.00	9884229.50	23061.29	5586.95	-2974.95
1612.7960	5313750.62	-17898365.75	9877855.12	22956.18	5607.17	-2985.23
1615.9690	5386334.50	-17880527.25	9868360.75	22794.69	5636.74	-2999.19
1618.1160	5435156.37	-17868406.00	9861913.62	22684.38	5654.64	-3006.57
1620.2570	5483600.75	-17856280.75	9855466.75	22569.80	5672.03	-3015.68
1622.4010	5531967.25	-17844103.00	9848995.00	22455.25	5687.82	-3021.47
1625.5750	5607863.37	-17826013.00	9839388.12	22280.67	5711.01	-3032.00
1627.7210	5656549.56	-17813743.00	9832874.87	22161.32	5724.45	-3038.10
1629.8640	5697916.81	-17801460.00	9826358.75	22039.48	5738.86	-3043.29
1632.0070	5745010.44	-17789149.00	9819831.62	21917.11	5750.63	-3048.21
1635.1810	5814262.44	-17770867.75	9810148.87	21732.37	5768.59	-3053.10
1637.3270	5860781.56	-17758476.25	9803594.37	21603.35	5779.95	-3055.51
1639.4710	5906961.00	-17746074.25	9797042.62	21474.84	5789.29	-3056.17
1641.6150	5952862.06	-17733650.75	9790489.62	21343.07	5799.57	-3056.70
1644.7100	6018623.25	-17715678.75	9781034.75	21152.03	5813.99	-3053.03
1646.7030	6060654.37	-17704079.50	9774954.37	21027.11	5826.29	-3048.86
1649.6490	6122320.94	-17686867.75	9765989.87	20837.31	5858.47	-3036.94
1651.6450	6163780.25	-17675141.25	9759936.00	20705.01	5891.46	-3029.09
1653.6380	6204908.56	-17663365.75	9753899.25	20568.17	5925.42	-3028.93
1656.5860	6265240.94	-17645810.00	9744960.12	20362.51	5984.76	-3035.51
1658.5790	6305679.56	-17633847.50	9738897.62	20218.54	6020.02	-3048.33
1663.7800	6409841.31	-17602328.50	9722878.87	19835.82	6100.32	-3111.52
1665.9370	6452454.94	-17589153.25	9716133.87	19676.40	6116.05	-3142.58
1668.0950	6494743.12	-17575946.50	9709316.87	19515.81	6123.68	-3175.42
1671.2840	6556592.00	-17556429.00	9699131.50	19272.77	6116.79	-3212.34
1673.4440	6598642.56	-17543230.50	9692171.87	19107.34	6103.91	-3231.70
1675.6010	6639076.12	-17530086.25	9685188.25	18939.81	6089.41	-3243.68
1680.9460	6739185.12	-17497653.75	9667853.25	18519.11	6043.95	-3242.76
1683.2220	6781117.56	-17483922.25	9660490.00	18328.40	6022.41	-3227.54
1685.4240	6821262.44	-17470683.50	9653407.12	18133.83	6001.84	-3205.57
1687.5640	6859862.69	-17457858.75	9646577.87	17940.93	5983.94	-3176.91
1689.7030	6898019.87	-17445085.75	9639815.50	17737.07	5959.08	-3146.08
1692.8670	6953049.56	-17426299.00	9629936.00	17427.07	5916.30	-3098.90
1695.0170	6990888.00	-17413613.25	9623307.50	17212.94	5884.18	-3067.01
1697.1590	7027525.50	-17401041.25	9616776.87	16995.75	5854.42	-3030.66
1702.4670	7116266.50	-17370119.75	9601958.25	16441.06	5796.54	-2929.66
1704.5610	7150451.25	-17357985.75	9594864.12	16209.21	5792.85	-2890.92
1709.5720	7230203.19	-17328929.75	9580560.12	15634.24	5808.62	-2820.43
1711.5630	7261122.56	-17317348.25	9574949.87	15393.52	5813.38	-2869.50
1714.5080	7305918.56	-17300235.25	9566670.00	15028.18	5808.43	-2813.50
1716.5320	7336672.94	-17288499.75	9561963.50	14768.80	5788.08	-2825.36
1718.6130	7366526.69	-17276694.25	9555065.12	14499.69	5750.10	-2843.38
1721.6750	7410311.56	-17259024.50	9546334.75	14099.05	5660.57	-2859.01
1723.7670	7439237.31	-17247381.00	9540415.50	13821.72	5578.33	-2854.55
1725.8920	7468570.44	-17235518.00	9534318.75	13528.25	5482.55	-2830.09
1728.0450	7497366.12	-17223826.50	9528275.62	13221.30	5378.10	-2783.60
1731.2250	7538676.56	-17206951.25	9519592.87	12760.18	5235.37	-2677.21
1733.3680	7566487.50	-17195826.00	9513947.50	12441.29	5147.57	-2591.51
1735.5150	7592249.12	-17184887.25	9508466.00	12122.36	5042.16	-2514.66
1737.6630	7617703.44	-17174190.25	9503156.12	11797.86	4931.80	-2436.32
1740.8290	7654324.37	-17158804.00	9495636.37	11314.08	4778.66	-2309.43
1742.9720	7678215.75	-17148675.25	9490778.12	10982.96	4674.16	-2224.64
1745.1120	7701367.00	-17138785.00	9486107.37	10653.60	4569.08	-2140.58
1747.2460	7723751.69	-17129146.75	9481629.12	10324.82	4463.87	-2056.48
1750.4170	7755716.50	-17115244.50	9475300.37	9836.40	4304.57	-1935.12
1752.5610	7776447.44	-17106133.25	9471237.12	9502.35	4194.75	-1855.28
1754.7040	7796455.06	-17097261.00	9467343.50	9170.09	4085.39	-1778.48

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Table B-1. Reconstructed Reentry Trajectory, ECI Coordinates (Continued)

GEMINI 10 ENTRY TRW BET V

EARTH CENTERED INERTIAL GREENWICH COORDINATE SYSTEM

TIME (SEC)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)
1756.8450	7815740.50	-17088627.75	9463614.87	8845.38	3979.32	-1704.61
1760.0140	7843019.75	-17076262.00	9458383.12	8370.87	3824.94	-1597.26
1762.1610	7860645.69	-17068141.25	9455031.37	8048.25	3739.77	-1524.97
1767.1700	7899104.31	-17049823.00	9447774.37	7307.56	3574.31	-1372.58
1769.1630	7913373.44	-17042756.75	9445086.62	7011.60	3516.74	-1324.62
1772.1080	7933380.06	-17032522.25	9441260.25	6575.36	3433.73	-1274.00
1774.1050	7946219.44	-17025727.75	9438739.50	6283.24	3371.05	-1250.52
1776.0960	7958446.44	-17019085.00	9436265.75	5999.05	3301.76	-1234.41
1779.0460	7975545.62	-17009519.50	9432652.75	5593.55	3183.19	-1215.10
1781.0440	7986458.25	-17003251.50	9430238.00	5330.08	3091.27	-1202.01
1784.0740	8002037.00	-16994117.75	9426639.25	4952.92	2937.62	-1173.46
1786.2240	8012410.56	-16987925.50	9424153.87	4696.82	2822.38	-1138.41
1788.3690	8022220.12	-16981993.50	9421760.12	4449.67	2708.83	-1093.59
1790.5140	8031506.37	-16976296.75	9419470.37	4210.73	2602.67	-1041.40
1795.8290	8052400.94	-16963051.25	9414308.37	3651.01	2381.58	-901.03
1797.9590	8059954.50	-16958052.75	9412443.00	3441.52	2311.71	-850.42
1800.0910	8067082.94	-16953198.75	9410679.00	3245.60	2241.85	-804.38
1803.3180	8077114.06	-16946133.50	9408183.12	2971.36	2136.99	-742.48
1805.5250	8083481.37	-16941490.50	9406588.25	2798.78	2070.42	-702.80
1807.6730	8089325.94	-16937109.25	9405118.00	2643.12	2008.95	-666.24
1809.8020	8094799.12	-16932894.75	9403737.00	2498.47	1950.35	-630.99
1812.9490	8102354.37	-16926885.50	9401831.50	2303.07	1868.64	-579.99
1815.0790	8107130.62	-16922959.00	9400631.25	2181.67	1818.17	-547.03
1819.2580	8115804.69	-16915551.00	9398471.50	1969.56	1727.23	-486.59
1822.3350	8121658.56	-16910332.00	9397040.25	1835.38	1664.91	-443.73
1824.4150	8125392.50	-16906909.00	9396144.12	1754.97	1626.54	-417.86
1826.4940	8128963.69	-16903564.00	9395301.37	1680.50	1591.44	-392.95
1829.5710	8133984.87	-16898740.50	9394148.12	1583.19	1543.67	-356.63
1831.6530	8137217.19	-16895561.25	9393427.25	1521.82	1510.39	-335.79
1836.8570	8144804.31	-16887906.75	9391807.50	1394.04	1431.42	-286.75
1838.9410	8147666.62	-16884952.25	9391224.37	1352.92	1403.98	-272.84
1841.0870	8150529.50	-16881963.50	9390649.62	1315.21	1381.32	-262.74
1843.2450	8153329.75	-16879006.00	9390092.75	1279.98	1359.73	-253.35
1846.3560	8157245.19	-16874826.50	9389321.25	1237.20	1327.11	-242.67
1848.4310	8159785.44	-16872096.50	9388825.62	1211.18	1304.31	-234.99
1850.5070	8162280.12	-16869413.25	9388345.62	1192.23	1280.70	-227.51
1853.5780	8165898.94	-16865536.50	9387654.12	1164.52	1243.98	-222.82
1855.6560	8168361.56	-16862975.50	9387196.12	1147.94	1221.11	-217.95
1860.7940	8174111.75	-16856824.00	9386107.37	1113.73	1173.35	-205.89
1862.8690	8176412.06	-16854465.75	9385686.37	1103.38	1157.44	-199.83
1866.0110	8180045.50	-16848549.75	9384675.25	1087.76	1120.32	-193.48
1870.0900	8184303.87	-16846237.50	9384274.37	1084.81	1103.96	-192.13
1872.1620	8186552.31	-16843976.25	9383876.37	1085.48	1078.81	-192.04
1875.2320	8189887.06	-16840725.00	9383288.62	1087.02	1039.27	-190.86
1877.3110	8192147.12	-16838585.50	9382887.75	1087.16	1018.86	-194.73
1879.3840	8194402.69	-16836489.50	9382483.87	1088.99	1003.29	-195.01
1882.4510	8197739.12	-16833443.00	9381885.00	1086.69	983.42	-195.47
1884.5290	8200001.37	-16831408.25	9381477.75	1090.62	975.01	-196.47
1886.6020	8202263.69	-16829394.25	9381072.37	1092.06	967.96	-194.64
1889.6710	8205613.69	-16826452.00	9380470.62	1091.05	949.47	-197.50
1891.7560	8207892.19	-16824481.00	9380064.12	1094.61	941.21	-192.46
1893.8390	8210164.37	-16822535.00	9379656.87	1087.00	927.24	-198.53
1896.9140	8213516.69	-16819698.75	9379044.00	1093.40	917.40	-200.09
1898.9960	8215802.12	-16817788.25	9378641.00	1102.00	917.97	-187.04
1901.0720	8218083.25	-16815900.25	9378243.75	1095.62	900.91	-195.68
1904.1450	8221461.00	-16813142.50	9377649.50	1102.69	893.93	-191.06
1906.2300	8223762.56	-16811277.00	9377267.87	1105.11	895.49	-175.07
1908.3070	8226072.25	-16809426.50	9376897.00	1118.94	886.48	-182.02
1910.3830	8228391.41	-16807589.00	9376525.62	1115.68	883.68	-175.79
1913.4620	8231834.56	-16804879.25	9375989.12	1120.61	876.40	-172.72
1915.5360	8234163.31	-16803074.50	9375621.87	1125.01	863.98	-181.44
1917.6160	8236503.56	-16801279.50	9375250.12	1125.21	862.07	-175.99
1920.6910	8239972.75	-16798634.00	9374707.50	1131.18	858.56	-176.96
1922.7700	8242316.31	-16796855.25	9374342.00	1123.37	852.51	-174.59
1924.8480	8244649.94	-16795083.50	9373987.25	1122.62	852.72	-166.90
1927.9230	8248119.06	-16792468.25	9373467.50	1133.75	848.33	-171.14
1930.0030	8250472.12	-16790706.75	9373116.75	1128.78	845.37	-166.09
1932.0810	8252816.87	-16788948.75	9372778.62	1127.98	846.75	-159.35
1935.1560	8256361.12	-16786351.00	9372277.87	1138.22	842.79	-166.33
1937.2350	8258665.06	-16784600.25	9371939.25	1135.83	841.43	-159.45
1939.3150	8261030.81	-16782847.25	9371613.12	1138.95	844.22	-154.18
1942.3870	8264523.69	-16780266.00	9371136.00	1135.06	836.23	-156.38
1944.4670	8266891.75	-16778527.00	9370813.37	1141.91	835.97	-153.85
1949.6200	8272787.31	-16774236.12	9370039.25	1146.31	829.41	-146.61
1951.7000	8275172.12	-16772507.00	9369739.50	1146.80	833.24	-141.67
1953.7740	8277581.19	-16770851.00	9369474.12	1176.25	763.70	-114.22
1956.8460	8281227.75	-16768586.00	9369168.62	1197.85	710.93	-84.64
1958.9270	8283721.37	-16767121.00	9369005.25	1198.69	696.97	-72.42
1961.0030	8286223.56	-16765684.75	9368863.50	1211.89	686.77	-64.14
1964.0750	8289961.62	-16763628.37	9368689.25	1221.75	652.00	-49.28
1966.1550	8292498.87	-16762302.00	9368592.00	1217.89	623.37	-44.28
1968.2320	8295029.42	-16761011.25	9368500.75	1219.02	619.55	-43.55
1971.3100	8298773.69	-16759107.62	9368372.62	1221.72	621.38	-39.96
1973.3840	8301427.37	-16757794.50	9368299.00	1229.05	638.88	-30.68
1975.4540	8303675.94	-16756470.75	9368235.62	1233.34	640.01	-30.55
1978.5250	8307657.50	-16754513.62	9368132.75	1229.41	634.59	-36.45
1980.6110	8310223.00	-16753190.00	9368056.25	1227.43	634.49	-36.93

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Table B-1. Reconstructed Reentry Trajectory, ECI Coordinates (Continued)

GEMINI 1C ENTRY TRW BET V

EARTH CENTERED INERTIAL GREENWICH COORDINATE SYSTEM

TIME (SEC)	X (FT)	Y (FT)	Z (FT)	XDOT (FT/SEC)	YDOT (FT/SEC)	ZDOT (FT/SEC)
1982.6850	8312769.87	-16751870.62	9367980.25	1231.44	637.85	-36.36
1985.7490	8316537.12	-16749923.37	9367860.25	1227.62	633.16	-41.95
1987.8320	8319081.44	-16748609.50	9367771.37	1215.34	628.42	-43.48
1989.9100	8321604.37	-16747306.75	9367683.87	1212.89	625.43	-40.75
1991.9860	8324132.00	-16746000.00	9367600.37	1222.21	633.46	-39.66
1995.0550	8327906.19	-16744045.87	9367472.25	1237.34	640.02	-43.84
1997.1250	8330467.44	-16742726.25	9367382.25	1237.28	635.01	-43.13
1999.2040	8333032.75	-16741405.00	9367296.87	1230.55	636.00	-38.92
2002.2840	8336814.37	-16739440.87	9367188.75	1225.04	639.37	-31.32
2004.3580	8339352.06	-16738120.00	9367114.25	1222.13	634.38	-40.55
2006.4390	8341888.31	-16736805.25	9367026.37	1215.35	629.18	-43.86
2009.5100	8345637.44	-16734865.87	9366893.50	1223.05	633.89	-42.65
2011.5910	8348181.06	-16733540.62	9366838.12	1226.40	639.77	-39.45
2013.6660	8350726.56	-16732220.37	9366716.75	1227.04	632.79	-48.65
2016.7420	8354501.50	-16730275.25	9366565.50	1227.42	631.87	-49.67
2018.8200	8357056.12	-16728954.75	9366470.37	1231.31	639.09	-41.87
2020.8990	8359610.56	-16727627.12	9366386.37	1226.05	638.05	-38.88
2023.9670	8363362.44	-16725676.25	9366262.50	1219.77	633.69	-41.93
2026.0480	8365892.87	-16724361.00	9366175.12	1212.21	630.39	-41.99
2031.1990	8372149.37	-16721103.25	9365958.25	1217.02	634.51	-42.22
2033.2790	8374685.75	-16719784.12	9365866.62	1221.81	633.85	-45.84
2035.3560	8377221.06	-16718461.62	9365778.37	1219.48	639.70	-39.21
2038.4290	8380973.75	-16716490.50	9365662.50	1222.92	643.11	-36.23
2040.5100	8383520.56	-16715159.37	9365577.75	1224.76	636.25	-45.16
2042.5850	8386066.50	-16713837.25	9365481.50	1228.63	638.03	-47.60
2045.6590	8389837.75	-16711875.62	9365338.87	1225.38	638.24	-45.18
2047.7350	8392388.12	-16710549.25	9365245.75	1231.66	639.60	-44.53
2049.8120	8394944.62	-16709224.00	9365147.12	1230.01	636.51	-50.47
2052.8929	8398722.12	-16707269.12	9364988.75	1222.11	632.54	-52.30
2054.9820	8401273.50	-16705945.50	9364883.37	1220.56	634.65	-48.64
2057.0630	8403817.37	-16704622.75	9364783.62	1224.39	636.62	-47.18
2060.1450	8407592.00	-16702660.75	9364635.50	1225.08	636.52	-49.00
2062.2260	8410136.00	-16701335.75	9364534.62	1219.80	636.98	-47.86

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Table B-2a. Reconstructed Reentry Trajectory, Special Parameters

GEMINI 10 ENTRY TRW BET V 51

TIME FROM RETROFIRE (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
1347.366	25864.6	24505.1	-1.635	87.658	383719.0	28.917	-99.989
1349.366	25866.4	24507.1	-1.633	87.731	382293.5	28.922	-99.843
1352.163	25868.8	24509.5	-1.631	87.841	380196.5	28.930	-99.628
1354.165	25870.6	24511.5	-1.630	87.915	378772.2	28.935	-99.482
1356.960	25873.0	24513.9	-1.627	88.025	376680.5	28.942	-99.268
1358.960	25874.6	24515.7	-1.626	88.099	375260.5	28.946	-99.122
1361.760	25877.1	24518.3	-1.624	88.209	373169.2	28.953	-98.907
1363.699	25878.8	24519.9	-1.622	88.283	371752.5	28.957	-98.761
1366.556	25881.2	24522.6	-1.619	88.393	369667.2	28.963	-98.546
1368.494	25882.9	24524.4	-1.618	88.468	368254.5	28.966	-98.400
1371.354	25885.4	24527.0	-1.615	88.577	366171.5	28.972	-98.184
1373.296	25887.1	24528.7	-1.614	88.652	364758.7	28.975	-98.038
1376.160	25889.4	24531.2	-1.611	88.761	362677.2	28.979	-97.822
1378.107	25891.2	24532.9	-1.609	88.836	361263.7	28.982	-97.676
1380.969	25893.5	24535.5	-1.607	88.947	359188.5	28.986	-97.460
1382.914	25895.2	24537.1	-1.605	89.021	357779.5	28.989	-97.313
1385.778	25897.4	24539.6	-1.603	89.132	355706.5	28.992	-97.097
1387.722	25899.2	24541.5	-1.601	89.207	354301.2	28.994	-96.951
1390.588	25901.5	24544.0	-1.599	89.317	352231.5	28.996	-96.734
1392.534	25903.4	24545.5	-1.597	89.392	350827.5	28.998	-96.587
1394.474	25904.6	24547.2	-1.595	89.466	349429.2	28.999	-96.441
1397.346	25906.9	24549.6	-1.592	89.577	347362.0	29.001	-96.224
1399.286	25908.5	24551.3	-1.590	89.651	345967.0	29.002	-96.078
1402.161	25910.8	24553.8	-1.588	89.762	343902.5	29.003	-95.861
1404.101	25912.2	24555.3	-1.586	89.837	342510.7	29.003	-95.714
1406.972	25914.5	24557.7	-1.584	89.948	340453.5	29.004	-95.497
1411.785	25918.3	24561.7	-1.579	90.133	337011.5	29.003	-95.133
1416.602	25921.7	24565.4	-1.574	90.319	333575.5	29.002	-94.769

GEMINI 10 ENTRY TRW BET V 52

TIME FROM RETROFIRE (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
1418.542	25923.3	24567.0	-1.572	90.394	332194.2	29.001	-94.623
1421.417	25925.4	24569.3	-1.570	90.505	330149.7	29.000	-94.405
1423.356	25927.0	24570.9	-1.567	90.580	328772.2	28.998	-94.258
1426.230	25928.9	24573.0	-1.565	90.691	326733.7	28.996	-94.041
1428.151	25930.0	24574.2	-1.563	90.765	325365.7	28.994	-93.895
1431.034	25932.1	24576.4	-1.560	90.877	323332.7	28.992	-93.678
1432.974	25933.4	24577.8	-1.558	90.952	321962.2	28.989	-93.531
1435.849	25935.4	24579.9	-1.555	91.063	319933.2	28.986	-93.313
1437.792	25936.7	24581.3	-1.553	91.137	318565.5	28.983	-93.166
1440.664	25938.5	24583.2	-1.550	91.249	316543.0	28.979	-92.949
1442.608	25939.5	24584.3	-1.547	91.324	315177.2	28.976	-92.802
1445.481	25940.9	24585.8	-1.544	91.435	313161.7	28.971	-92.584
1447.425	25941.6	24586.7	-1.542	91.511	311800.0	28.968	-92.437
1450.300	25942.8	24587.9	-1.539	91.622	309789.7	28.962	-92.220
1452.243	25943.5	24588.7	-1.536	91.697	308433.2	28.958	-92.072
1455.117	25944.4	24589.8	-1.533	91.808	306430.0	28.952	-91.855
1457.060	25944.9	24590.3	-1.530	91.883	305078.0	28.948	-91.708
1459.933	25945.5	24591.0	-1.527	91.994	303087.5	28.941	-91.490
1461.875	25945.7	24591.4	-1.525	92.069	301735.7	28.936	-91.343
1464.748	25945.8	24591.6	-1.521	92.179	299747.0	28.928	-91.126
1466.692	25945.8	24591.7	-1.519	92.254	298403.5	28.923	-90.979
1469.565	25945.6	24591.7	-1.515	92.364	296421.5	28.915	-90.761
1471.510	25945.4	24591.5	-1.512	92.439	295082.5	28.909	-90.614
1474.594	25944.4	24590.6	-1.508	92.559	292964.0	28.900	-90.381
1476.760	25943.9	24590.3	-1.505	92.643	291479.5	28.893	-90.217
1478.922	25942.9	24589.3	-1.502	92.727	290000.2	28.886	-90.053
1481.081	25941.6	24588.1	-1.500	92.812	288525.7	28.878	-89.890
1483.242	25940.1	24586.7	-1.497	92.896	287052.2	28.871	-89.726

GEMINI 10 ENTRY TRW BET V 53

TIME FROM RETROFIRE (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
1486.440	25937.5	24584.8	-1.493	93.022	284876.2	28.859	-89.485
1488.606	25934.7	24581.6	-1.490	93.107	283405.7	28.851	-89.321
1490.765	25931.7	24578.7	-1.487	93.192	281943.0	28.843	-89.158
1492.926	25928.3	24575.4	-1.484	93.275	280481.0	28.834	-88.994
1496.122	25922.7	24570.0	-1.479	93.400	278325.5	28.821	-88.753
1498.285	25918.5	24565.8	-1.475	93.485	276870.5	28.812	-88.589
1500.446	25913.8	24561.2	-1.471	93.571	275421.5	28.803	-88.426
1502.608	25908.8	24556.4	-1.468	93.656	273975.0	28.793	-88.263
1504.766	25903.1	24550.8	-1.465	93.741	272534.5	28.783	-88.100
1507.968	25893.7	24541.5	-1.461	93.867	270402.5	28.768	-87.859
1510.130	25886.6	24534.5	-1.457	93.952	268966.2	28.758	-87.696
1512.289	25878.5	24526.5	-1.452	94.036	267536.7	28.747	-87.533
1514.450	25869.9	24518.0	-1.446	94.121	266112.0	28.737	-87.370
1517.648	25855.9	24504.2	-1.437	94.246	264014.2	28.720	-87.130
1519.814	25844.9	24493.3	-1.433	94.330	262600.0	28.709	-86.967
1521.969	25833.2	24481.6	-1.428	94.413	261198.5	28.697	-86.805
1524.124	25821.0	24469.5	-1.421	94.495	259803.0	28.686	-86.643
1527.314	25801.9	24450.5	-1.410	94.617	257750.7	28.668	-86.403
1529.468	25787.5	24436.2	-1.403	94.699	256374.5	28.656	-86.242
1531.625	25771.4	24420.2	-1.397	94.780	255003.2	28.643	-86.080
1533.777	25753.9	24402.8	-1.391	94.862	253641.7	28.630	-85.919
1536.949	25727.2	24376.3	-1.378	94.983	251650.0	28.611	-85.682
1539.099	25707.3	24356.5	-1.369	95.064	250311.0	28.598	-85.521
1541.246	25685.3	24334.5	-1.363	95.143	248982.2	28.585	-85.361
1543.391	25661.7	24311.0	-1.355	95.224	247662.5	28.571	-85.201
1546.565	25625.6	24275.1	-1.339	95.343	245728.7	28.551	-84.965
1548.713	25598.6	24248.2	-1.330	95.422	244433.5	28.537	-84.805
1550.861	25567.1	24219.7	-1.323	95.502	243146.2	28.523	-84.646

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Table B-2a. Reconstructed Reentry Trajectory, Special Parameters (Continued)

GEMINI 10 ENTRY TRW BET V 54

TIME FROM RETROFIRE (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
1553.004	25540.6	24190.4	-1.312	95.582	241872.5	28.508	-84.487
1556.177	25495.1	24145.0	-1.295	95.697	240008.7	28.487	-84.253
1558.327	25462.1	24112.0	-1.286	95.780	238760.2	28.472	-84.094
1560.475	25427.0	24077.0	-1.276	95.861	237522.7	28.457	-83.936
1562.622	25391.4	24041.5	-1.263	95.937	236298.2	28.442	-83.778
1564.764	25354.1	24004.2	-1.253	96.017	235089.5	28.426	-83.620
1567.945	25295.2	23945.4	-1.238	96.132	233315.0	28.403	-83.387
1570.088	25252.8	23903.2	-1.224	96.209	232135.7	28.387	-83.231
1572.230	25207.1	23857.6	-1.213	96.288	230970.0	28.371	-83.074
1574.373	25158.6	23809.1	-1.201	96.362	229817.2	28.355	-82.918
1577.545	25080.7	23731.3	-1.178	96.478	228139.2	28.331	-82.688
1579.696	25022.1	23672.8	-1.164	96.552	227020.7	28.314	-82.533
1581.839	24962.8	23613.6	-1.147	96.631	225924.0	28.297	-82.378
1583.984	24899.5	23550.4	-1.132	96.705	224843.5	28.281	-82.224
1587.159	24800.9	23451.9	-1.108	96.817	223276.2	28.255	-81.996
1589.306	24729.9	23380.9	-1.090	96.890	222239.2	28.238	-81.843
1591.448	24657.0	23308.0	-1.074	96.965	221223.0	28.221	-81.691
1593.594	24582.7	23233.8	-1.053	97.038	220224.5	28.203	-81.539
1596.771	24468.0	23119.3	-1.029	97.147	218782.2	28.177	-81.314
1598.920	24388.9	23040.2	-1.008	97.221	217831.0	28.159	-81.163
1601.069	24306.5	22957.8	-.994	97.293	216901.2	28.141	-81.013
1603.201	24223.5	22874.9	-.973	97.362	215992.7	28.123	-80.864
1606.373	24095.3	22746.8	-.950	97.467	214680.0	28.096	-80.644
1608.519	24007.0	22658.5	-.929	97.541	213815.2	28.078	-80.496
1610.657	23914.2	22565.7	-.915	97.604	212972.5	28.059	-80.349
1612.796	23818.9	22470.5	-.896	97.674	212147.5	28.041	-80.203
1615.969	23672.1	22323.8	-.872	97.775	210958.0	28.013	-79.987
1618.116	23571.1	22222.8	-.851	97.840	210177.0	27.995	-79.842

GEMINI 10 ENTRY TRW BET V 55

TIME FROM RETROFIRE (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
1620.257	23466.2	22118.0	-.837	97.910	209416.0	27.976	-79.698
1622.401	23360.6	22012.4	-.817	97.973	208672.7	27.957	-79.555
1625.575	23196.9	21851.8	-.795	98.071	207605.0	27.929	-79.343
1627.721	23089.5	21741.4	-.778	98.137	206904.2	27.910	-79.202
1629.864	22976.8	21628.8	-.766	98.200	206219.7	27.891	-79.061
1632.007	22863.1	21515.1	-.750	98.264	205551.0	27.872	-78.921
1635.181	22691.3	21343.3	-.730	98.353	204589.2	27.843	-78.715
1637.327	22571.0	21223.0	-.720	98.411	203955.2	27.824	-78.577
1639.471	22450.5	21102.6	-.704	98.467	203336.2	27.805	-78.439
1641.615	22327.2	20979.3	-.695	98.521	202730.7	27.785	-78.303
1644.710	22147.9	20800.0	-.681	98.589	201876.2	27.757	-78.107
1646.703	22031.4	20683.3	-.679	98.624	201336.2	27.739	-77.982
1649.649	21857.2	20509.0	-.708	98.643	200527.2	27.713	-77.799
1651.645	21739.0	20390.6	-.758	98.642	199952.7	27.695	-77.676
1653.638	21617.9	20269.5	-.827	98.655	199337.5	27.677	-77.553
1656.586	21439.8	20091.2	-.964	98.678	198320.7	27.651	-77.374
1658.579	21314.8	19966.3	-1.064	98.718	197549.7	27.634	-77.253
1663.780	20984.6	19636.6	-1.357	98.906	195185.0	27.588	-76.942
1665.937	20843.3	19495.6	-1.452	99.018	194060.5	27.569	-76.815
1668.095	20699.0	19351.8	-1.536	99.146	192872.5	27.550	-76.689
1671.284	20473.7	19127.1	-1.616	99.331	191039.2	27.521	-76.504
1673.444	20317.3	18971.0	-1.649	99.454	189765.0	27.501	-76.380
1675.601	20157.4	18811.4	-1.673	99.562	188480.2	27.482	-76.258
1680.946	19748.5	18403.1	-1.692	99.764	185302.7	27.433	-75.959
1683.222	19560.6	18215.2	-1.693	99.815	183961.2	27.412	-75.834
1685.424	19368.4	18023.0	-1.698	99.844	182673.5	27.392	-75.714
1687.564	19177.5	17832.1	-1.706	99.849	181429.7	27.373	-75.599
1689.703	18974.0	17628.4	-1.709	99.856	180195.5	27.354	-75.485

GEMINI 10 ENTRY TRW BET V 56

TIME FROM RETROFIRE (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
1692.867	18663.0	17317.3	-1.712	99.868	178391.2	27.326	-75.319
1695.017	18447.6	17101.9	-1.715	99.879	177179.7	27.307	-75.208
1697.159	18229.5	16883.6	-1.726	99.872	175982.2	27.289	-75.099
1702.467	17677.4	16333.9	-1.817	99.789	172997.0	27.245	-74.835
1704.561	17454.3	16107.5	-1.929	99.724	171778.2	27.228	-74.733
1709.570	16915.2	15568.0	-2.353	99.577	168531.2	27.188	-74.495
1711.563	16692.8	15345.7	-2.574	99.567	167077.2	27.173	-74.403
1714.558	16355.4	15008.9	-2.928	99.628	164722.2	27.151	-74.269
1716.532	16112.2	14766.4	-3.163	99.726	162962.5	27.136	-74.179
1718.613	15855.3	14510.5	-3.380	99.876	161049.5	27.121	-74.088
1721.675	15459.6	14116.3	-3.610	100.125	158106.2	27.098	-73.957
1723.747	15175.8	13833.4	-3.698	100.287	156068.7	27.083	-73.870
1725.892	14868.8	13527.0	-3.742	100.411	153963.0	27.067	-73.783
1728.045	14542.2	13201.7	-3.749	100.478	151879.2	27.051	-73.697
1731.225	14049.9	12708.2	-3.755	100.618	148883.2	27.029	-73.574
1733.368	13711.3	12369.1	-3.782	100.303	146914.2	27.014	-73.494
1735.515	13367.8	12025.4	-3.774	100.248	144985.2	27.000	-73.416
1737.660	13017.2	11674.6	-3.761	100.192	143112.5	26.986	-73.340
1740.829	12497.1	11153.8	-3.776	100.030	140437.2	26.967	-73.232
1742.972	12141.7	10798.0	-3.800	99.914	138681.0	26.954	-73.162
1745.112	11788.0	10443.8	-3.829	99.793	136966.2	26.942	-73.094
1747.246	11434.9	10090.3	-3.863	99.661	135293.5	26.931	-73.029
1750.417	10911.0	9564.8	-3.926	99.468	132872.5	26.915	-72.936
1752.561	10551.4	9205.8	-3.986	99.338	131275.5	26.905	-72.876
1754.704	10195.3	8849.3	-4.061	99.210	129706.7	26.895	-72.818
1756.845	9847.9	8501.7	-4.151	99.077	128161.5	26.886	-72.763
1760.014	9340.9	7994.3	-4.311	98.861	125907.5	26.873	-72.684
1762.161	9004.8	7657.8	-4.537	98.641	124381.0	26.865	-72.634

Table B-2a. Reconstructed Reentry Trajectory, Special Parameters (Continued)

GEMINI 10 ENTRY TRW BET V 57

TIME FROM RETROFIRE (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
1767.170	8249.9	6902.8	-5.353	98.044	120654.5	26.847	-72.525
1769.163	7955.2	6608.8	-5.819	97.823	119078.2	26.841	-72.485
1772.108	7926.5	6182.2	-6.657	97.589	116598.0	26.833	-72.429
1774.105	7239.3	5897.1	-7.273	97.514	114806.7	26.828	-72.393
1776.096	6958.0	5618.6	-7.897	97.514	112937.7	26.823	-72.359
1779.046	6549.6	5214.9	-8.771	97.619	110048.0	26.816	-72.312
1781.044	6277.8	4946.6	-9.302	97.751	108032.2	26.811	-72.282
1784.274	5876.9	4550.9	-9.954	97.975	104949.5	26.804	-72.240
1786.224	5596.6	4273.5	-10.307	98.052	102776.2	26.800	-72.212
1788.369	5322.9	4002.4	-10.618	98.037	100646.5	26.795	-72.186
1790.514	5058.5	3740.4	-10.943	97.939	98560.7	26.791	-72.162
1795.829	4451.3	3140.0	-12.027	97.164	93536.5	26.782	-72.109
1797.959	4232.2	2925.2	-12.651	96.768	91558.2	26.779	-72.091
1800.091	4025.8	2723.8	-13.261	96.402	89583.2	26.776	-72.074
1803.318	3734.6	2441.3	-14.172	95.901	86614.7	26.773	-72.050
1805.525	3551.6	2265.3	-14.812	95.534	84601.7	26.771	-72.036
1807.673	3386.1	2107.2	-15.427	95.165	82657.5	26.769	-72.023
1809.802	3231.8	1960.8	-16.030	94.776	80747.0	26.767	-72.011
1812.949	3022.0	1763.9	-16.885	94.144	77960.0	26.765	-71.996
1815.079	2892.2	1644.3	-17.472	93.675	76099.2	26.764	-71.986
1819.258	2664.5	1438.6	-18.570	92.704	72510.5	26.762	-71.970
1822.335	2517.4	1307.8	-19.254	91.940	69926.7	26.762	-71.960
1824.415	2429.0	1231.4	-19.685	91.440	68212.2	26.761	-71.954
1826.494	2347.6	1162.9	-20.109	90.915	66522.7	26.761	-71.948
1829.571	2239.8	1074.2	-20.638	90.094	64066.0	26.761	-71.941
1831.653	2170.2	1018.6	-20.969	89.619	62435.7	26.761	-71.936
1836.857	2018.5	900.0	-21.498	88.479	58490.7	26.761	-71.927
1838.941	1968.9	863.2	-21.672	88.151	56962.5	26.762	-71.924

GEMINI 10 ENTRY TRW BET V 58

TIME FROM RETROFIRE (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
1841.087	1925.3	833.9	-21.916	87.879	55411.7	26.762	-71.921
1843.245	1884.5	807.5	-22.146	87.619	53870.0	26.762	-71.919
1846.356	1831.5	771.5	-22.332	87.393	51683.7	26.763	-71.915
1848.431	1795.4	747.4	-22.381	87.251	50253.5	26.763	-71.913
1850.507	1764.5	723.3	-22.259	87.179	48850.5	26.764	-71.911
1853.578	1718.5	688.8	-22.121	87.300	46831.2	26.765	-71.909
1855.656	1690.1	667.4	-21.987	87.321	45502.2	26.765	-71.908
1860.794	1630.0	623.7	-21.651	87.309	42331.5	26.766	-71.905
1862.869	1611.5	608.8	-21.475	87.245	41095.7	26.766	-71.904
1866.011	1573.5	575.8	-20.960	87.441	38132.7	26.767	-71.902
1870.090	1559.6	561.0	-20.650	87.617	36976.0	26.768	-71.902
1872.162	1542.4	538.0	-20.069	88.006	35858.2	26.768	-71.901
1875.232	1516.0	501.7	-19.100	88.597	34284.7	26.768	-71.901
1877.311	1502.6	485.1	-18.674	89.063	33269.2	26.769	-71.900
1879.384	1493.5	471.1	-18.254	89.342	32285.7	26.769	-71.900
1882.451	1478.6	454.7	-17.827	89.667	30874.2	26.769	-71.899
1884.529	1476.0	446.6	-17.531	89.876	29942.2	26.769	-71.899
1886.602	1472.2	439.2	-17.282	89.941	29028.0	26.769	-71.899
1889.671	1459.8	425.2	-16.881	90.349	27706.2	26.769	-71.898
1891.754	1454.4	414.7	-16.491	90.333	26833.2	26.769	-71.898
1893.839	1442.5	408.5	-16.418	90.736	25978.0	26.769	-71.898
1896.914	1441.2	399.0	-16.018	91.014	24739.5	26.769	-71.898
1898.996	1446.4	390.0	-15.591	90.593	23920.7	26.768	-71.898
1901.072	1431.9	382.5	-15.441	91.156	23121.5	26.768	-71.898
1904.165	1432.3	372.0	-14.991	91.162	21966.0	26.768	-71.897
1906.236	1433.1	364.3	-14.691	90.567	21201.0	26.768	-71.897
1908.307	1439.1	355.9	-14.227	91.083	20456.5	26.768	-71.897
1910.383	1434.1	351.4	-14.116	90.881	19725.7	26.768	-71.897

GEMINI 10 ENTRY TRW BET V 59

TIME FROM RETROFIRE (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
1913.462	1433.1	342.1	-13.737	90.934	18663.2	26.767	-71.897
1915.536	1430.0	335.3	-13.437	91.501	17965.7	26.767	-71.897
1917.616	1428.4	330.6	-13.278	91.338	17278.7	26.767	-71.896
1920.691	1431.1	326.4	-13.046	91.483	16277.5	26.767	-71.896
1922.770	1421.0	322.5	-13.015	91.446	15608.5	26.767	-71.896
1924.848	1419.6	318.7	-12.897	91.157	14946.7	26.766	-71.896
1927.923	1426.3	313.8	-12.576	91.475	13981.7	26.766	-71.896
1930.000	1420.0	310.1	-12.514	91.307	13338.7	26.766	-71.896
1932.081	1419.4	307.7	-12.445	91.033	12721.2	26.766	-71.895
1935.156	1426.0	304.9	-12.207	91.438	11767.0	26.766	-71.895
1937.235	1422.5	300.7	-12.096	91.194	11143.5	26.765	-71.895
1939.315	1426.1	299.1	-12.002	90.981	10525.0	26.765	-71.895
1942.387	1418.5	294.7	-11.895	91.174	9620.2	26.765	-71.895
1944.467	1423.5	291.0	-11.678	91.139	9016.2	26.765	-71.894
1949.620	1422.5	286.3	-11.246	91.027	7558.5	26.764	-71.894
1951.700	1424.6	283.5	-11.248	90.789	6981.2	26.764	-71.894
1953.774	1407.1	202.1	-8.089	91.175	6487.7	26.764	-71.893
1956.846	1395.5	138.7	-5.494	91.144	5977.7	26.764	-71.893
1958.927	1389.5	120.2	-4.810	90.939	5717.7	26.764	-71.893
1961.003	1394.4	105.1	-4.076	90.910	5493.7	26.764	-71.893
1964.075	1385.7	68.4	-2.498	91.029	5248.7	26.764	-71.893
1966.155	1368.9	48.3	-1.530	91.307	5147.7	26.763	-71.893
1968.232	1368.1	46.1	-1.362	91.358	5075.7	26.763	-71.893
1971.300	1371.2	43.1	-1.297	91.218	4978.0	26.763	-71.893
1973.384	1389.5	46.0	-1.564	90.636	4906.2	26.763	-71.892
1975.454	1399.8	47.5	-1.516	90.650	4828.7	26.763	-71.892
1978.525	1384.0	47.1	-1.505	90.935	4716.5	26.763	-71.892
1980.611	1382.2	47.0	-1.537	90.942	4639.7	26.762	-71.892

Table B-2a. Reconstructed Reentry Trajectory, Special Parameters (Continued)

GEMINI IC ENTRY TRW BET V 60

TIME FROM RETROFIRE (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
1982.685	1387.3	49.2	-1.558	90.899	4562.0	26.762	-71.892
1985.749	1381.9	50.1	-1.564	91.163	4446.2	26.762	-71.892
1987.832	1368.9	49.0	-1.645	91.212	4365.7	26.762	-71.892
1989.910	1365.3	45.6	-1.531	91.146	4287.0	26.762	-71.892
1991.986	1377.2	47.7	-1.603	91.043	4209.0	26.762	-71.892
1995.055	1393.8	57.1	-1.617	91.207	4089.2	26.761	-71.891
1997.125	1391.4	53.7	-1.435	91.268	4012.2	26.761	-71.891
1999.204	1385.7	49.1	-1.498	91.050	3938.2	26.761	-71.891
2002.284	1382.2	44.6	-1.552	90.675	3824.5	26.761	-71.891
2004.358	1377.6	48.3	-1.604	91.084	3745.5	26.761	-71.891
2006.439	1369.3	48.8	-1.607	91.249	3665.5	26.761	-71.891
2009.510	1378.2	49.7	-1.591	91.187	3547.5	26.760	-71.891
2011.591	1383.8	50.6	-1.657	90.997	3465.7	26.760	-71.890
2013.666	1381.5	54.6	-1.581	91.466	3385.0	26.760	-71.890
2016.742	1381.4	55.1	-1.551	91.528	3268.0	26.760	-71.890
2018.820	1387.9	52.6	-1.566	91.149	3190.0	26.760	-71.890
2020.899	1382.7	48.6	-1.561	91.021	3111.0	26.759	-71.890
2023.967	1375.2	48.2	-1.574	91.166	2995.2	26.759	-71.890
2026.048	1367.0	47.2	-1.593	91.171	2916.2	26.759	-71.890
2031.199	1373.1	48.6	-1.628	91.155	2717.2	26.759	-71.890
2033.275	1377.2	51.4	-1.581	91.342	2637.2	26.758	-71.890
2035.356	1377.6	48.7	-1.683	90.981	2555.5	26.758	-71.890
2038.429	1382.2	48.5	-1.666	90.846	2431.2	26.758	-71.889
2040.510	1380.9	51.9	-1.568	91.311	2350.2	26.758	-71.889
2042.585	1385.2	55.4	-1.595	91.404	2270.5	26.758	-71.889
2045.659	1382.4	52.8	-1.603	91.292	2151.7	26.757	-71.889
2047.735	1388.5	54.0	-1.517	91.296	2073.0	26.757	-71.889
2049.812	1385.9	57.2	-1.547	91.560	1996.0	26.757	-71.889

GEMINI IC ENTRY TRW BET V 61

TIME FROM RETROFIRE (SECONDS)	INERTIAL VEL. MAGNITUDE (FT/SEC)	RELATIVE VEL. MAGNITUDE (FT/SEC)	INERTIAL FLT. PATH ANGLE (DEGREES)	INERTIAL HEADING ANGLE (DEGREES)	ALTITUDE (FEET)	GEODETIC LAT. (DEGREES)	GEODETIC LONG. (DEGREES)
2052.893	1377.1	56.2	-1.579	91.644	1879.5	26.757	-71.889
2054.982	1376.6	53.4	-1.600	91.464	1799.5	26.757	-71.888
2057.063	1380.8	53.2	-1.561	91.408	1720.2	26.756	-71.888
2060.145	1381.4	54.8	-1.568	91.488	1603.7	26.756	-71.888
2062.226	1376.9	53.4	-1.648	91.403	1523.0	26.756	-71.888

Table B-2b. Reconstructed Reentry Trajectory, Special Parameters

GEMINI 10 ENTRY TRW BET V 82

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
1347.366	-1.726	87.523	-94.359	28.754	21293164.0
1349.306	-1.724	87.601	-94.206	28.759	21291733.0
1352.163	-1.721	87.716	-93.979	28.767	21289628.0
1354.105	-1.720	87.795	-93.825	28.772	21288198.5
1356.969	-1.718	87.910	-93.598	28.779	21286099.5
1358.909	-1.716	87.989	-93.444	28.784	21284674.7
1361.769	-1.714	88.105	-93.217	28.790	21282576.7
1363.699	-1.712	88.183	-93.063	28.794	21281155.7
1366.556	-1.709	88.299	-92.836	28.800	21279064.7
1368.494	-1.707	88.378	-92.682	28.804	21277648.0
1371.354	-1.705	88.493	-92.455	28.809	21275559.7
1373.296	-1.703	88.572	-92.300	28.812	21274143.5
1376.160	-1.700	88.688	-92.073	28.817	21272057.5
1378.107	-1.699	88.767	-91.918	28.819	21270641.0
1380.969	-1.696	88.884	-91.690	28.823	21268561.5
1382.914	-1.694	88.962	-91.535	28.826	21267150.0
1385.778	-1.691	89.079	-91.307	28.829	21265074.0
1387.722	-1.690	89.158	-91.153	28.831	21263666.5
1390.584	-1.687	89.274	-90.924	28.834	21261594.0
1392.534	-1.685	89.353	-90.769	28.835	21260188.5
1394.474	-1.683	89.432	-90.615	28.836	21258788.7
1397.346	-1.680	89.548	-90.386	28.838	21256719.7
1399.286	-1.678	89.627	-90.231	28.839	21255324.0
1402.161	-1.676	89.744	-90.002	28.840	21253258.2
1404.101	-1.674	89.823	-89.848	28.840	21251866.0
1406.972	-1.671	89.940	-89.619	28.841	21249808.5
1411.785	-1.666	90.136	-89.235	28.841	21246366.7
1416.602	-1.661	90.332	-88.851	28.839	21242932.2

GEMINI 10 ENTRY TRW BET V 83

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
1418.542	-1.659	90.411	-88.696	28.838	21241551.7
1421.417	-1.656	90.528	-88.466	28.837	21239509.0
1423.355	-1.654	90.607	-88.312	28.836	21238132.7
1426.233	-1.651	90.724	-88.082	28.833	21236096.5
1428.161	-1.649	90.803	-87.928	28.832	21234730.2
1431.034	-1.646	90.922	-87.699	28.829	21232700.2
1432.974	-1.644	90.999	-87.544	28.827	21231332.0
1435.849	-1.641	91.117	-87.314	28.823	21229306.7
1437.790	-1.638	91.196	-87.159	28.820	21227941.7
1440.664	-1.635	91.313	-86.930	28.816	21225923.5
1442.608	-1.633	91.393	-86.774	28.813	21224561.0
1445.481	-1.629	91.510	-86.545	28.808	21222550.5
1447.425	-1.627	91.590	-86.390	28.805	21221192.5
1450.302	-1.623	91.707	-86.160	28.799	21219187.7
1452.243	-1.621	91.786	-86.005	28.795	21217835.2
1455.117	-1.617	91.903	-85.775	28.789	21215838.5
1457.060	-1.615	91.982	-85.620	28.785	21214491.0
1459.933	-1.611	92.099	-85.391	28.778	21212502.5
1461.875	-1.609	92.178	-85.236	28.773	21211160.7
1464.748	-1.605	92.295	-85.006	28.766	21209179.7
1466.692	-1.602	92.374	-84.851	28.761	21207841.7
1469.565	-1.599	92.490	-84.621	28.752	21205868.2
1471.510	-1.596	92.569	-84.466	28.747	21204535.0
1474.594	-1.591	92.695	-84.220	28.737	21202426.2
1476.760	-1.588	92.784	-84.047	28.730	21200949.0
1478.922	-1.585	92.873	-83.874	28.723	21199477.0
1481.381	-1.582	92.962	-83.702	28.716	21198010.0
1483.242	-1.579	93.052	-83.529	28.708	21196544.5

GEMINI 10 ENTRY TRW BET V 84

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
1486.440	-1.575	93.185	-83.274	28.697	21194380.5
1488.666	-1.572	93.274	-83.101	28.689	21192918.5
1490.765	-1.569	93.363	-82.929	28.680	21191464.2
1492.926	-1.566	93.451	-82.757	28.672	21190011.2
1496.122	-1.561	93.583	-82.502	28.659	21187869.0
1498.285	-1.556	93.673	-82.329	28.650	21186423.5
1500.446	-1.552	93.763	-82.157	28.640	21184984.0
1502.608	-1.549	93.853	-81.985	28.631	21183547.5
1504.766	-1.545	93.943	-81.813	28.621	21182117.0
1507.968	-1.541	94.076	-81.558	28.606	21180000.2
1510.130	-1.538	94.166	-81.386	28.596	21178574.7
1512.289	-1.532	94.255	-81.215	28.585	21177156.2
1514.450	-1.526	94.344	-81.043	28.575	21175742.5
1517.648	-1.517	94.476	-80.789	28.558	21173661.5
1519.814	-1.512	94.565	-80.617	28.547	21172259.0
1521.969	-1.507	94.653	-80.446	28.536	21170869.2
1524.124	-1.500	94.739	-80.275	28.524	21169485.7
1527.314	-1.488	94.868	-80.022	28.506	21167451.7
1529.468	-1.480	94.955	-79.852	28.494	21166088.2
1531.625	-1.474	95.041	-79.681	28.481	21164729.7
1533.777	-1.468	95.128	-79.511	28.469	21163391.2
1536.949	-1.454	95.256	-79.260	28.450	21161409.0
1539.099	-1.445	95.341	-79.091	28.437	21160083.5
1541.246	-1.438	95.426	-78.922	28.424	21158768.2
1543.391	-1.430	95.512	-78.753	28.410	21157462.5
1546.555	-1.413	95.638	-78.503	28.390	21155549.5
1548.713	-1.404	95.721	-78.335	28.376	21154268.5
1550.861	-1.397	95.806	-78.166	28.362	21152996.0

Table B-2b. Reconstructed Reentry Trajectory, Special Parameters (Continued)

GEMINI IC ENTRY TRW BET V 85

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
1553.004	-1.385	95.891	-77.999	28.347	21151737.0
1556.177	-1.367	96.013	-77.751	28.326	21149895.2
1558.327	-1.358	96.102	-77.583	28.311	21148661.7
1560.475	-1.348	96.187	-77.416	28.296	21147439.7
1562.622	-1.334	96.268	-77.249	28.281	21146231.0
1564.764	-1.323	96.353	-77.083	28.265	21145037.7
1567.945	-1.308	96.476	-76.836	28.242	21143287.0
1570.088	-1.293	96.558	-76.671	28.227	21142123.7
1572.230	-1.281	96.642	-76.506	28.211	21140974.5
1574.373	-1.269	96.721	-76.341	28.194	21139838.0
1577.545	-1.245	96.845	-76.097	28.170	21138184.7
1579.696	-1.231	96.924	-75.933	28.154	21137083.2
1581.839	-1.212	97.009	-75.769	28.137	21136003.5
1583.984	-1.196	97.088	-75.606	28.120	21134944.2
1587.159	-1.171	97.208	-75.365	28.095	21133398.5
1589.306	-1.153	97.287	-75.203	28.078	21132379.0
1591.448	-1.136	97.367	-75.042	28.061	21131380.5
1593.594	-1.115	97.446	-74.880	28.043	21130399.7
1596.771	-1.089	97.564	-74.643	28.017	21128984.0
1598.927	-1.067	97.643	-74.483	27.999	21128051.0
1601.063	-1.052	97.721	-74.324	27.981	21127139.5
1603.201	-1.036	97.796	-74.166	27.963	21126249.2
1606.373	-1.006	97.910	-73.933	27.937	21124963.7
1608.519	-.985	97.990	-73.776	27.918	21124117.5
1610.657	-.969	98.059	-73.620	27.900	21123293.2
1612.796	-.949	98.135	-73.465	27.882	21122487.0
1615.969	-.924	98.245	-73.236	27.854	21121325.5
1618.116	-.903	98.317	-73.081	27.835	21120563.2

GEMINI IC ENTRY TRW BET V 86

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
1620.257	-.888	98.393	-72.928	27.817	21119821.5
1622.401	-.867	98.463	-72.776	27.798	21119097.0
1625.575	-.845	98.571	-72.552	27.770	21118057.7
1627.721	-.827	98.643	-72.401	27.751	21117376.2
1629.864	-.814	98.712	-72.251	27.732	21116711.0
1632.007	-.797	98.784	-72.102	27.713	21116061.5
1635.181	-.776	98.883	-71.883	27.685	21115128.2
1637.327	-.765	98.948	-71.736	27.665	21114513.7
1639.471	-.749	99.011	-71.589	27.646	21113914.2
1641.615	-.740	99.072	-71.444	27.627	21113328.0
1644.713	-.725	99.148	-71.236	27.599	21112501.7
1646.763	-.723	99.189	-71.102	27.581	21111979.7
1649.649	-.755	99.214	-70.907	27.555	21111197.2
1651.645	-.809	99.216	-70.775	27.537	21110640.5
1653.638	-.882	99.234	-70.644	27.519	21110043.0
1656.586	-1.028	99.263	-70.452	27.494	21109052.5
1658.579	-1.135	99.309	-70.323	27.476	21108299.0
1663.780	-1.450	99.519	-69.991	27.430	21105980.2
1665.937	-1.553	99.644	-69.855	27.411	21104874.7
1668.095	-1.643	99.785	-69.719	27.392	21103706.0
1671.284	-1.730	99.990	-69.521	27.363	21101901.5
1673.444	-1.766	100.128	-69.389	27.344	21100646.7
1675.601	-1.793	100.249	-69.257	27.324	21099381.7
1680.946	-1.816	100.482	-68.936	27.276	21096252.7
1683.222	-1.818	100.544	-68.801	27.255	21094932.0
1685.424	-1.825	100.583	-68.672	27.235	21093664.0
1687.564	-1.835	100.596	-68.548	27.216	21092439.5
1689.703	-1.839	100.613	-68.425	27.197	21091224.0

GEMINI IC ENTRY TRW BET V 87

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
1692.867	-1.845	100.639	-68.246	27.169	21089447.5
1695.017	-1.850	100.661	-68.126	27.151	21088254.5
1697.159	-1.864	100.664	-68.008	27.133	21087075.2
1702.467	-1.966	100.601	-67.722	27.088	21084134.0
1704.561	-2.090	100.541	-67.611	27.071	21082932.2
1709.573	-2.557	100.410	-67.352	27.032	21079724.2
1711.553	-2.800	100.410	-67.252	27.017	21078285.2
1714.508	-3.191	100.495	-67.106	26.995	21075952.0
1716.532	-3.452	100.616	-67.007	26.980	21074207.2
1716.613	-3.694	100.795	-66.907	26.965	21072309.5
1721.675	-3.954	101.094	-66.763	26.942	21069388.7
1723.747	-4.058	101.292	-66.668	26.927	21067366.2
1725.892	-4.114	101.451	-66.572	26.911	21065276.0
1728.045	-4.131	101.551	-66.477	26.896	21063207.7
1731.225	-4.152	101.527	-66.341	26.873	21060234.0
1733.368	-4.193	101.429	-66.252	26.859	21058279.5
1735.515	-4.196	101.401	-66.165	26.845	21056364.2
1737.667	-4.195	101.373	-66.080	26.831	21054505.0
1740.829	-4.231	101.247	-65.959	26.812	21051848.7
1742.972	-4.274	101.158	-65.880	26.799	21050105.0
1745.112	-4.322	101.064	-65.803	26.787	21048402.0
1747.246	-4.379	100.959	-65.729	26.776	21046740.2
1750.417	-4.480	100.811	-65.622	26.760	21044335.0
1752.561	-4.570	100.714	-65.553	26.750	21042748.2
1754.704	-4.680	100.622	-65.487	26.740	21041189.0
1756.845	-4.810	100.526	-65.422	26.731	21039653.0
1760.014	-5.038	100.366	-65.331	26.718	21037411.7
1762.161	-5.338	100.174	-65.272	26.710	21035893.2

Table B-2b. Reconstructed Reentry Trajectory, Special Parameters (Continued)

GEMINI 10 ENTRY TRW BET V 88

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
1767.172	-6.461	99.628	-65.142	26.693	21032183.5
1769.163	-7.009	99.433	-65.093	26.687	21030613.2
1772.109	-8.114	99.262	-65.025	26.678	21028141.2
1774.105	-8.941	99.252	-64.981	26.673	21026355.0
1776.096	-9.796	99.342	-64.938	26.668	21024491.0
1779.046	-11.041	99.623	-64.879	26.661	21021608.2
1781.044	-11.837	99.937	-64.840	26.656	21019597.0
1784.274	-12.899	100.396	-64.786	26.650	21016521.0
1786.224	-13.551	100.662	-64.749	26.645	21014352.2
1788.369	-14.185	100.827	-64.714	26.641	21012226.7
1790.514	-14.876	100.857	-64.681	26.637	21010145.0
1795.829	-17.181	100.380	-64.606	26.628	21005129.5
1797.959	-18.474	100.051	-64.579	26.625	21003154.2
1800.941	-19.818	99.762	-64.553	26.622	21001182.0
1803.318	-21.905	99.434	-64.516	26.618	20998217.0
1805.525	-23.629	99.114	-64.492	26.616	20996276.0
1807.673	-25.337	98.801	-64.476	26.614	20994263.5
1809.862	-27.073	98.446	-64.450	26.613	20992354.7
1812.949	-29.841	97.762	-64.421	26.611	20989569.5
1815.379	-31.892	97.192	-64.403	26.610	20987716.0
1819.258	-36.184	95.760	-64.369	26.608	20984122.7
1822.335	-39.414	94.449	-64.346	26.607	20981540.0
1824.415	-41.640	93.445	-64.331	26.607	20979826.0
1826.494	-43.953	92.261	-64.317	26.607	20978136.5
1829.571	-47.300	90.104	-64.297	26.606	20975680.0
1831.653	-49.688	88.647	-64.284	26.606	20974049.7
1836.857	-55.278	84.220	-64.253	26.607	20970104.2
1838.941	-57.383	82.470	-64.241	26.607	20968575.7

GEMINI 10 ENTRY TRW BET V 89

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
1841.087	-59.509	80.753	-64.229	26.608	20967024.5
1843.245	-61.608	78.836	-64.217	26.608	20965482.5
1846.356	-64.369	76.343	-64.201	26.609	20963295.5
1848.431	-66.148	74.388	-64.190	26.609	20961865.0
1850.507	-67.934	72.738	-64.180	26.610	20960461.5
1853.578	-69.961	71.077	-64.165	26.610	20958441.5
1855.656	-71.465	69.375	-64.155	26.611	20957112.0
1860.794	-74.736	63.804	-64.131	26.612	20953940.5
1862.869	-75.757	60.811	-64.121	26.612	20952706.2
1868.011	-77.836	56.669	-64.098	26.613	20949740.2
1870.090	-78.633	56.070	-64.088	26.613	20948583.2
1872.162	-79.676	57.765	-64.079	26.614	20947465.2
1875.232	-81.381	61.293	-64.066	26.614	20945891.2
1877.311	-82.616	66.992	-64.057	26.614	20944875.5
1879.384	-83.269	71.614	-64.048	26.614	20943892.0
1882.451	-84.572	77.456	-64.034	26.614	20942480.5
1884.529	-84.563	84.273	-64.025	26.614	20941548.2
1886.602	-84.781	86.298	-64.016	26.614	20940634.0
1889.671	-85.573	103.067	-64.003	26.614	20939312.5
1891.756	-85.515	102.580	-63.994	26.614	20938439.5
1893.839	-86.397	131.968	-63.986	26.614	20937584.2
1896.914	-85.438	139.353	-63.972	26.614	20936346.0
1898.996	-85.341	115.352	-63.964	26.614	20935527.2
1901.072	-85.250	150.643	-63.955	26.614	20934728.0
1904.145	-84.814	145.616	-63.942	26.614	20933573.0
1906.232	-85.989	120.648	-63.933	26.614	20932808.0
1908.307	-83.552	130.230	-63.924	26.613	20932063.5
1910.393	-84.505	128.191	-63.915	26.613	20931333.0

GEMINI 10 ENTRY TRW BET V 90

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
1913.462	-84.040	128.531	-63.902	26.613	20930270.7
1915.536	-82.338	143.912	-63.893	26.613	20929573.2
1917.616	-82.845	141.267	-63.884	26.613	20928886.5
1920.691	-81.817	140.250	-63.871	26.612	20927885.5
1922.770	-82.857	149.996	-63.863	26.612	20927216.7
1924.848	-83.696	144.681	-63.854	26.612	20926555.2
1927.923	-81.742	141.981	-63.841	26.612	20925590.5
1930.003	-82.899	144.959	-63.832	26.612	20924947.7
1932.081	-83.833	138.138	-63.823	26.611	20924310.2
1935.156	-81.407	139.475	-63.810	26.611	20923376.2
1937.245	-82.489	136.734	-63.801	26.611	20922753.0
1939.315	-82.537	126.988	-63.792	26.611	20922134.5
1942.387	-82.781	139.362	-63.779	26.611	20921230.0
1944.467	-81.954	132.082	-63.770	26.610	20920626.2
1949.627	-81.820	127.972	-63.748	26.610	20919169.0
1951.700	-82.125	119.050	-63.739	26.610	20918591.7
1953.774	-78.345	134.053	-63.730	26.610	20918098.2
1956.846	-74.373	137.545	-63.717	26.610	20917588.7
1958.927	-75.546	138.707	-63.709	26.609	20917328.7
1961.003	-76.613	128.951	-63.700	26.609	20917105.0
1964.075	-61.944	140.376	-63.687	26.609	20916860.0
1966.156	-49.235	172.133	-63.678	26.609	20916759.2
1968.232	-44.924	173.593	-63.669	26.609	20916687.5
1971.307	-46.038	166.715	-63.656	26.609	20916590.0
1973.384	-55.292	125.758	-63.648	26.608	20916518.2
1975.454	-56.767	121.487	-63.639	26.608	20916441.0
1978.529	-56.546	138.839	-63.626	26.608	20916328.7
1980.611	-52.077	141.759	-63.617	26.608	20916252.2

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Table B-2b. Reconstructed Reentry Trajectory, Special Parameters (Continued)

GEMINI IC ENTRY TRN BET V 91

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
1982.685	-50.037	138.382	-63.668	26.608	20916174.5
1985.749	-48.837	149.040	-63.595	26.608	20916059.0
1988.432	-51.324	171.475	-63.586	26.608	20915978.7
1989.911	-53.167	178.350	-63.578	26.607	20915900.0
1991.986	-53.876	152.972	-63.569	26.607	20915822.2
1995.055	-43.531	135.012	-63.556	26.607	20915702.7
1997.125	-40.419	138.727	-63.547	26.607	20915626.0
1999.204	-47.533	139.911	-63.538	26.607	20915552.0
2002.284	-57.151	132.034	-63.525	26.606	20915438.5
2004.354	-52.900	153.176	-63.516	26.606	20915359.7
2006.439	-51.815	170.944	-63.508	26.606	20915279.7
2009.511	-50.392	154.213	-63.495	26.606	20915162.0
2011.591	-52.322	141.068	-63.486	26.606	20915080.5
2013.666	-44.242	154.467	-63.477	26.606	20914999.7
2016.742	-42.749	155.454	-63.464	26.605	20914883.2
2018.823	-46.176	139.746	-63.455	26.605	20914805.2
2020.899	-53.843	143.243	-63.446	26.605	20914726.5
2023.967	-51.584	158.892	-63.434	26.605	20914610.7
2026.048	-53.584	174.802	-63.425	26.605	20914532.0
2031.199	-53.371	162.514	-63.403	26.604	20914333.5
2033.279	-47.654	158.447	-63.394	26.604	20914253.5
2035.356	-50.247	150.608	-63.386	26.604	20914172.0
2038.429	-56.018	138.665	-63.373	26.604	20914048.0
2040.517	-46.705	152.452	-63.364	26.604	20913967.0
2042.585	-44.139	148.553	-63.355	26.603	20913887.5
2045.659	-47.100	150.074	-63.342	26.603	20913769.0
2047.735	-42.875	142.391	-63.333	26.603	20913690.5
2049.812	-40.834	152.535	-63.324	26.603	20913613.7

GEMINI IC ENTRY TRN BET V 92

TIME (SEC)	RELATIVE FLT. PATH ANGLE (DEGREES)	RELATIVE HEADING ANGLE (DEGREES)	INERTIAL LONG. (DEGREES)	GEOCENTRIC LAT. (DEGREES)	RADIUS TO EARTH CENTER (FEET)
2052.833	-42.514	162.501	-63.311	26.602	20913497.5
2054.982	-45.979	161.124	-63.303	26.602	20913417.7
2057.063	-44.992	154.206	-63.294	26.602	20913338.5
2060.145	-43.638	154.736	-63.281	26.602	20913222.5
2062.226	-47.798	159.771	-63.272	26.601	20913141.7

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APPENDIX C

TRACKER CALIBRATION DATA

1. GE MOD III

The following calibration data were used in the processing of the GE/MOD III tracking data. The values listed below are the parameters which vary from flight to flight; approximately 40 other scaling and calibration biases associated with the MOD III data reduction remain the same for each flight. A complete description of the use of each parameter in the data reduction is included in Section 4.4.2.2 of the TRW Gemini Analysis Plan, Reference 1.

Zero-Set Calibration Data

Range (J_1)	=	-1793.343 ft
Azimuth (J_3)	=	-130.72247°
Elevation (J_5)	=	-15.05196°
Squint Angle (J_4)	=	0.01511°

Refraction

Ground Index of Refraction (J_2) = 1.000380

The calibration values used by TRW and GE are, as far as known, identical. The General Electric Co. postflight report on the calibration procedures and flight constants used on this mission may be found in Reference 7. However, the refraction correction calculated by GE is based on the measured atmosphere while the TRW correction relies on an analytical model which is a function of the ground-measured index of refraction. This model is defined in Reference 1. Curves of the TRW refraction correction for a typical Gemini flight are shown in Figures C-1 and C-2.

2. MISTRAM

Responsibility for reduction of the MISTRAM data lies with RCA/PAA at the Eastern Test Range. Their analysis results are reported in the Gemini 10 "Red Book" of trajectory data, References 4 and 5. The following calibration data were extracted from these documents:

	R (ft)	P1 (ft)	Q1 (ft)	P2 (ft)	Q2 (ft)
Calibrations	211.6487	-79.4601	-38.2355	-77.0259	-45.1216
Accumulated transfers	0	-10140.3628	-7.6259	-3.2479	-1.4389
Transponder delay	-8.3700				
BIAS**	-0.0540	-3.8897	1.8573	-2.8815	0.9605
Total	203.2247	-10223.7126	-44.0041	-83.1553	-45.6000

Index of Refraction

Central Receiver = 1.000387

P_2 Site = 1.000387

Q_2 Site = 1.000387

Having corrected the raw measurements as well as possible, all the available MISTRAM as well as "C" band radar data were used by the ETR to form a minimum variance estimate of the spacecraft trajectory. Additional MISTRAM bias errors are solved for in this regression and are recorded in Table 4-1 of this report for comparison with TRW results. The "fully corrected" but unsmoothed measurement data were used by TRW in their simultaneous IGS/tracker error regression program.

Figures

**Data prior to 153.55 sec were biased to agree with data after 153.55 sec. The bias was calculated by extrapolating from 153.55 sec backwards and agreement of the comparison between 10K and 100K base lines.

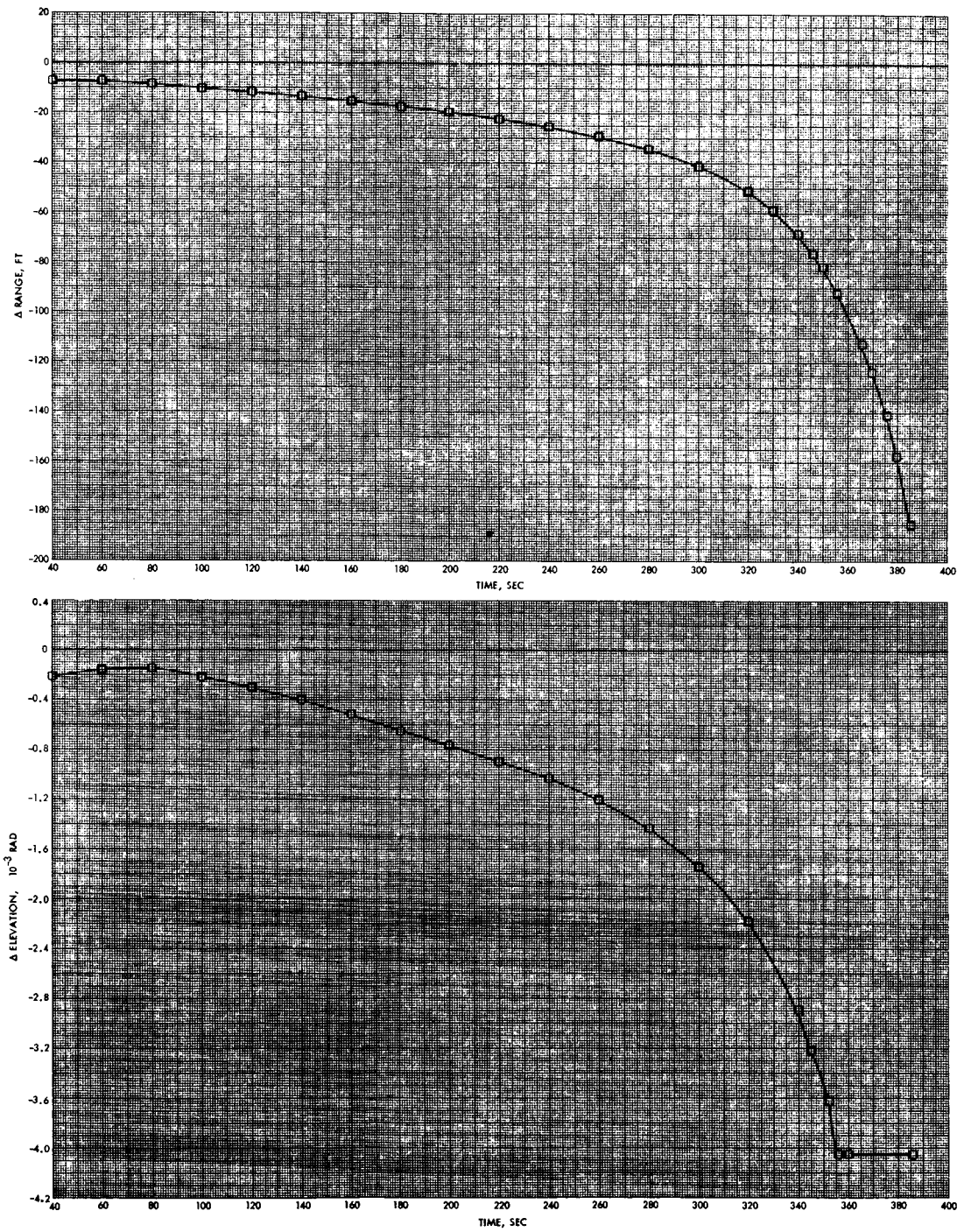

Figure C-1. GE MOD III Refraction Corrections (Range and Elevation)

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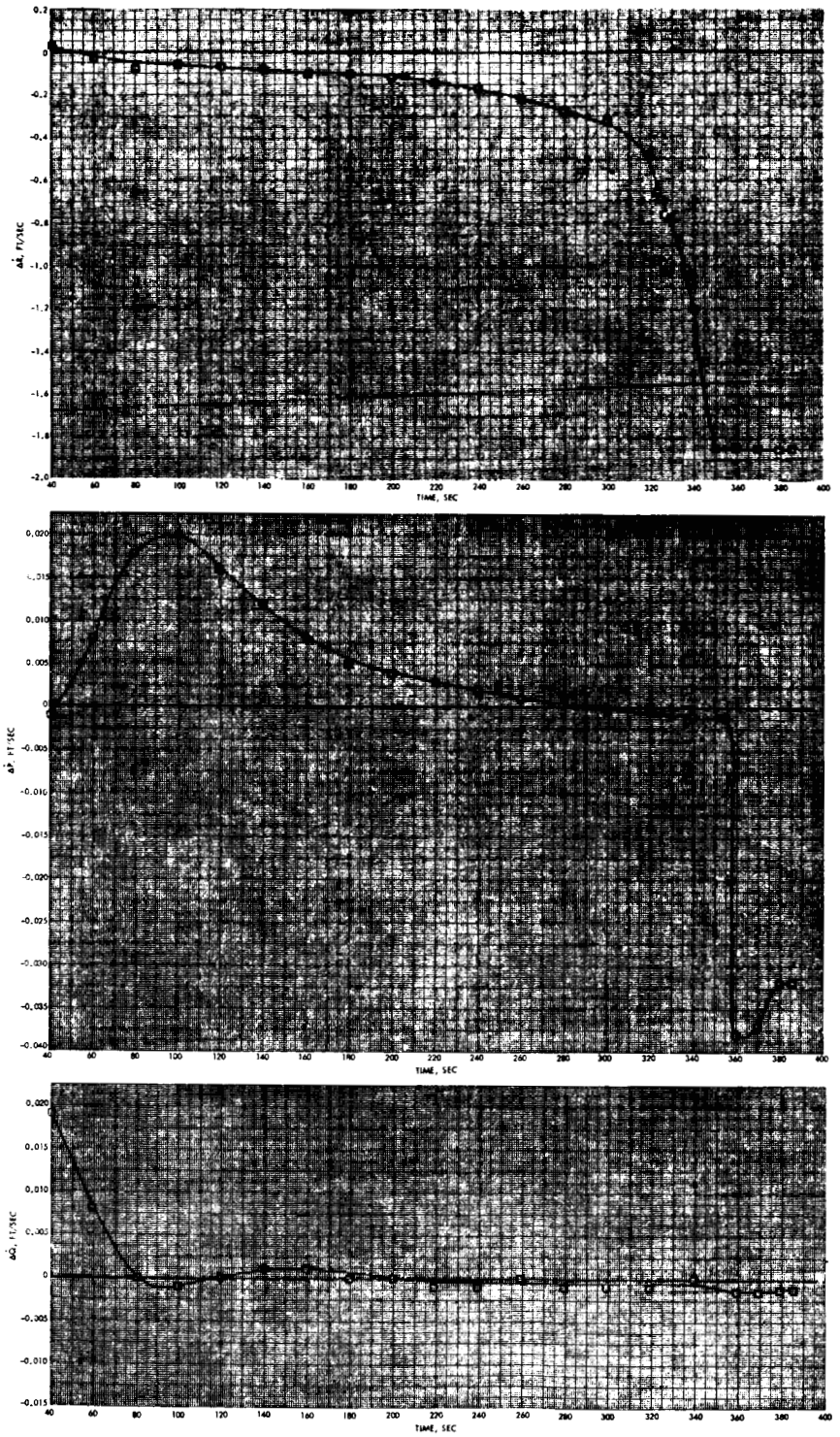

Figure C-2. GE MOD III Refraction Corrections (Range Rate, $\dot{P}$, and $\dot{Q}$)

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REFERENCES

1. F. B. Lavenhar, "Preliminary Gemini G and C Data Reduction and Analysis Plan," Technical Report 4160-6009-TU-000, TRW Systems, 30 October 1964.

2. R. Sansom, "Gemini Inertia Measurement Unit Accuracy Prediction Study (U)," Technical Report 4160-6016-TW000, TRW Systems, 8 February 1965 (Confidential).

3. "Gemini 10 Orbit and Reentry Trajectory Reconstruction," Technical Report 05952-6061-R000, TRW Systems, 14 November 1966.

4. "Final Flight Test Data MISTRAM Coordinate Systems No. 1 and 3, AFETR Test No. 3287," Gemini Missile No. GT-11, OD Item 9.2.1.3-20, AFETR Data Reduction, no date.

5. "Final Flight Test Data Best Estimate of Trajectory Coordinate Systems No. 1 and 3, AFETR Test No. 3287," Gemini Missile No. GT-11, OD Item No. 9.2.1.3-26.

6. "NASA Gemini Mission Program Report, Gemini 11 (U) MSC-G-R-66-8, November 1966 (Confidential).

7. "Flight Test Report MOD III Guidance System With Gemini Launch Vehicle 10" Range Test No. 6833 Gemini Titan 10 (U), dated 18 July 1966, General Electric Company.

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