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SECTION 7 G&N ERROR ANALYSES

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7. G&N Error Analyses

7.0 This volume, Section 7 of the Guidance System Operations Plan, G&N Error Analysis for CSM, was based on the 504 Mission (AS-504 and 504 Booster). During the preparation of this error study, the GSOP format changed from a mission-oriented to a program-oriented emphasis. The current nomenclature COLOSSUS represents a program that is applicable to all manned CM earth orbital and lunar missions. The reader should remember that this error study was made for the 504 mission with its particular configuration of burns plus reentry. It may be regarded as a specific study of a mission that uses COLOSSUS.

7.1 Introduction

The results of a preliminary error study of the effects of IMU component errors in CSM guidance and navigation for the 504 mission are given here. The significant trajectories, from the error analysis point of view, for the 504 mission are: 1) earth launch or boost to orbit, 2) translunar injection, 3) lunar orbit insertion, 4) transearth injection, and 5) earth reentry.

For the first two trajectories, earth boost and translunar injection (2nd SIVB burn), Saturn guidance is primary, while CSM guidance and navigation monitors these maneuvers. For these trajectories the uncertainties given in the error tables are indication uncertainties (where uncertainty equals indicated position or velocity minus the actual). For the other trajectories CM guidance is, of course, primary. No attempt is made here to consider the effects of errors in the backup modes of operation.

Error studies for these trajectories (except for earth launch) include the effects of uncertainties in the state vector or navigational updates assumed to take place just prior to the start of each burn and prior to reentry. The CSM IMU Stable Member is fine-aligned to the desired orientation prior to the start of each trajectory on the basis of star sightings and guidance computer calculations.

7.2 Summary of Error Studies

Table 7.1 summarizes some of the principal results of the error studies. This table gives the one sigma uncertainties in position and velocity at the end of each trajectory due to Block II IMU uncertainties. The uncertainties due to each of the major IMU uncertainty sources are also shown. These sources are: Stable Member misalignments, accelerometer and gyro drift uncertainties. This enables a quick evaluation of the relative contribution of these major sources to the overall RSS uncertainties. More information about the uncertainties associated with these trajectories may be found in Section 7.11 and 7.12 as well as in the error tables themselves, which are located at the end of this section.

Table 7.2 summarizes the data on RSS uncertainties due to IMU component uncertainties and to navigational update uncertainties as well as to their combined effects. For transearth injection, updating with on-board computed data on the basis of orbital navigation and landmark tracking was assumed. All other updates, however, were assumed to use processed tracking data from earth-based radar tracking stations. These data are discussed in the next section. Inspection of Table 7.2 shows that update uncertainties have a greater effect than IMU uncertainties on cutoff uncertainties for all trajectories except earth reentry.

Table 7.1

Summary of Trajectory Cutoff Uncertainties due to IMU Uncertainties for 504 Mission

Trajectory	Uncertainty Source	Position Uncertainties (ft.)			Velocity Uncertainties (ft/sec)		
		Alt.	Track	Range	Alt.	Track	Range
Earth Launch (1st SIVB C.O.)	Mlms.	164	2,079	214	0.58	5.37	0.42
	Accel.	2,981	906	1,370	9.66	3,29	3.38
	Gyros	598	26,520	866	2.35	68.72	2.10
	RSS	3,045	26,617	1,635	9.95	69.01	4.00
Trans-lunar Injection	Mlms	286	291	95	2.04	1.99	0.54
	Accel.	402	408	414	2.42	2.41	2.46
	Gyros	223	228	73	1.69	1.66	0.44
	RSS	542	550	431	3.59	3.53	2.55
Lunar Orbit Insertion	Mlms	113	104	38	0.64	0.58	0.19
	Accel.	488	480	481	2.60	2.49	2.49
	Gyros	88	81	29	0.53	0.48	0.16
	RSS	509	497	483	2.73	2.60	2.50
Trans-earth Injection	Mlms	29	29	3	0.51	0.51	0.03
	Accel.	47	49	50	0.79	0.82	0.84
	Gyros	21	21	2	0.37	0.37	0.02
	RSS	59	61	50	1.01	1.04	0.84
Reentry (at 24,000 feet)	Mlms	0	2,175	81	59.93	6.03	4.99
	Accel.	0	1,849	1,988	48.52	5.03	6.75
	Gyros	0	5,082	306	134.32	16.22	9.29
	RSS	0	5,829	2,013	154.88	18.02	12.52
	CEP	4,627 Feet			—		

Note: Mlms is used as an abbreviation for "misalignment"

Table 7.2

Summary of Trajectory Cutoff Uncertainties due to IMU and Tracking Update Uncertainties for 504 Mission

Trajectory	Uncertainty Source	Position Uncertainties (feet)			Velocity Uncertainties (ft/sec)		
		Alt.	Track	Range	Alt.	Track	Range
Earth Launch (1st SIVB C.O.)	IMU	3,045	26,617	1,635	9.96	69.01	4.00
	Tkg. Data	---	---	--	--	--	---
	RSS	3,045	26,617	1,635	9.96	69.01	4.00
Trans-lunar Injection	IMU	542	550	431	3.59	3.53	2.55
	Tkg. Data	783	386	6,848	7.85	0.18	0.97
	RSS	952	672	6,861	8.63	3.54	2.73
Lunar Orbit Insertion	IMU	509	497	483	2.73	2.60	2.50
	Tkg. Data	1,072	7,268	4,646	4.26	11.03	0.37
	RSS	1,187	7,285	4,671	5.06	11.33	2.53
Trans-earth Injection	IMU	59	61	50	1.01	1.04	0.84
	Orbit. Nav.	530	533	2,835	1.83	0.77	0.43
	RSS	533	536	2,835	2.09	1.29	0.95
Reentry (at 24,000 feet)	IMU	0	5,829	2,013	154.88	18.02	12.52
	Tkg. Data	0	1,468	506	6.55	1.68	1.11
	RSS	0	6,011	2,075	155.02	18.09	12.57
	CEP	4,770 feet			—		

At the end of this chapter detailed error tables are given for the four powered trajectories and for reentry. For each trajectory the following error tables are given:

1) Position and velocity uncertainties
2) Uncertainties in flight path angle, velocity magnitude, etc.
3) S. M. misalignments and drift angles summary

In addition, there are a number of supplementary error tables, including those giving data on covariance matrices and on maximum altitude uncertainties in orbit after earth and lunar orbit insertion.

7.3 Navigational Updates

Prior to the significant CSM burns as well as prior to translunar injection and to reentry, there will be navigational (or state vector) updates of the CM computer's computed data on spacecraft position and velocity. With the possible exception of the update before transearth injection these updates will be made on the basis of observations made by the radar tracking stations of the Manned Space Flight Network (MSFN). Uncertainties in the tracking data exist because of the presence of radar noise, bias, uncertainties in station location and in the knowledge of earth (or moon) gravitational constant. The covariance matrices (one sigma) for the tracking uncertainties existing just prior to each powered trajectory and to reentry were obtained from "Preliminary MSFN Error Analysis for AS-504A" by P. H. Mitchell (MSC Internal Note No. 67-FM-29, March 1, 1967, MSC, Houston, Texas).

The one sigma position and velocity uncertainties, as obtained from the diagonal terms of these covariance matrices are given in the following table relative to local vertical axes at the start of each trajectory. The update position and velocity uncertainties just prior to translunar injection include the relatively large effects of uncertainty in knowledge of acceleration due to venting. These affect particularly the range position and altitude rate uncertainties.

Trajectory	Position Uncert. (ft)			Velocity Uncert. (ft/sec)		
	Alt.	Track	Range	Alt.	Track	Range
T. L. I	1,267	393	6,122	7.09	0.14	0.49
L. O. I	2,366	11,208	3,314	2.18	8.90	0.83
T. E. I	108	1,310	133	0.11	1.26	0.05
Reentry	239	392	716	0.59	2.40	0.15

Update Uncertainties at Trajectory Starts

Table 7.3

In conjunction with the error runs the tracking uncertainty covariance matrices are propagated through these trajectories and reentry to cutoff. The corresponding position and velocity uncertainties are listed at the bottom of the principal error tables together with the RSS uncertainties due to IMU component uncertainties and the combined RSS uncertainties.

The propagated covariance matrices due to tracking uncertainties and to IMU component uncertainties are also given for lunar orbit insertion cutoff in Table 7.16.

Prior to transearth injection an alternative mode of navigational updating may be used. This uses CSM on-board navigational data computed on the basis of lunar landmark tracking. The error study for this chapter assumed this alternate update mode. Update uncertainties at T.E.I. trajectory start were (in ft and f/sec):

Alt.	Track	Range	Alt.	Track	Range
517	522	2,843	1.83	0.76	0.42

7.4 IMU Errors and Uncertainties

IMU errors can be classed into two groups. These are: (1) those errors that the CMC (command module computer) can provide compensation for, and (2) those errors for which there is no compensation.

IMU errors are compensated as follows. The average error for the particular IMU component is first determined on the basis of system tests extending over many months. The negative of the computed average error is then stored in the CMC shortly before earth launch. Pre-launch and in-flight compensation is then effected by means of stored programs in the CMC. The rms IMU component uncertainties are then the unpredictable deviations of the actual instantaneous error from the assumed average error.

Table 7.4 lists the Block II one-sigma IMU error uncertainties that were assumed for the error studies in this chapter. These are the same as those given on pg. 3-25 of MEI No. 2015000, Part I, which lists Block II specifications for the Apollo Command Module.

The following IMU errors are errors that the guidance computer is equipped to compensate for:

1) Accelerometer bias error
2) Accelerometer scale factor error
3) Gyro bias drift
4) Gyro input axis accel. sens. drift
5) Gyro spin ref. axis accel. sens. drift

These are defined and discussed in some detail in subsections 7.5 and 7.6.

Table 7.4

Block II One-Sigma IMU Error Uncertainties

Error	Error Symbol	Compen-sated?	RMS Uncertainty (after compen-sation when applicable	Error Units
Accelerometer Errors				
Bias Error	ACB	Yes	0.20	cm/sec^2
S.F. Error	SFE	Yes	116	ppm
Accel. Sqd. Ind. Error	NC	No	10	$\mu g/g^2$
Input Axis Misalign.	α	No	20	secs.
Gyro Errors				
Bias Drift	NBD	Yes	2	meru
IA Accel. Sens. Drift	ADIA	Yes	8	meru/g
SRA Accel. Sens. Drift	ADSRA	Yes	5	meru/g
OA Accel. Sens. Drift	ADOA	No	1*	meru/g
IA Misalign. about SRA	γ_{SRA}	No	300	secs.
IA Misalign. about OA	γ_{OA}	No	300	secs.
Stable Member Alignment Errors				
Prelaunch Azimuth	---	No	50**	secs.
Vertical	---	No	5**	secs.
Free-fall All Axes	---	No	20	secs.

* Listed value for ADOA is not a Block II uncertainty. It represents a reasonable value used for the error studies.

** The error values listed for S.M. prelaunch azimuth and vertical alignments are not those listed in MEI No. 2015000. They represent present estimates for these misalignments.

The computer does not provide compensation for the following IMU errors:

1) Stable Member initial misalignments (those that are uncorrelated with gyro drift)
2) Accelerometer input axis misalignments
3) Accelerometer acceleration-squared indication uncertainties
4) Gyro output axis acceleration sensitive drift
5) Gyro acceleration-squared sensitive drift
6) Gyro input axis misalignments

The subject of Stable Member initial misalignments will be covered in Section 7.9. It should be noted that those sources of initial S. M. alignment errors directly due to gyro bias drift (for all alignment modes) and to acceleration sensitive drift and to accelerometer bias (for earth launch alignment) will, of course, be compensated for.

Accelerometer input axis misalignments will be covered in the next subsections.

Both accelerometer acceleration squared indication uncertainty and gyro acceleration squared senstivie drift are difficult and time-consuming to measure and for this reason and because their effects on trajectory uncertainties are secondary they are not compensated for. The effects of vibrations operating through these uncertainties and through rectification effects may well have a greater effect than that produced by powered trajectory or reentry accelerations. However, no attempt was made to study vibration effects in this chapter.

Gyro output axis acceleration sensitive drift (ADOA) is a relatively difficult error to measure. The value of 1 meru/g for ADOA is a reasonable estimate for this uncertainty.

Gyro input axis misalignments affect trajectory uncertainties only in their effect on Stable Member azimuth misalignment prior to earth launch alignment when gyro compassing is used for azimuth alignment.

Since none of the above IMU errors are compensated for, uncertainties are the same as errors for this group.

7.5 Accelerometer Error Coefficients

Accelerometer bias (ACB) is defined as the indicated acceleration of the accelerometer with zero input acceleration. Bias is positive when the indicated acceleration is positive. This bias is due to torques about the output axis of the PIPA.

Accelerometer scale factor error (SFE) is defined as the deviation in the actual PIPA scale factor from the nominal scale factor divided by the nominal scale factor. The scale factor itself is conventionally defined as a given number of cm/sec^2 per

pulse/sec. delivered to the computer. The scale factor error is positive when the measured scale factor (in cm/sec^2 per pulse/sec or cm/sec per pulse) is greater than the nominal. However, it should be carefully noted that when scale factor error is thought of as the deviation of indicated acceleration from the input acceleration divided by the input acceleration (where ideal scale factor would then be unity), the above definition of positive scale factor error corresponds to an indicated acceleration less than the input acceleration.

Accelerometer input axis misalignments are not compensated for. A positive misalignment is a positive rotation of the input axis about the appropriate S. M. axis. There are two misalignments associated with each accelerometer. The misalignment of the Z accelerometer input axis about YSM is zero by definition. (See definition of Stable Member axes in Section 7.7). However, for earth prelaunch alignment of the Stable Member the alignment of the two accelerometers, whose input axes are in the horizontal plane, is considered to be perfect relative to the horizontal plane. This, of course, assumes zero bias accelerometers. For the 504 earth launch configuration with X SM horizontal and Z SM down this means that the misalignments of XI A about YSM and of YIA about XSM are both effectively zero.

7.6 Gyro Drift Coefficients and S. M. Drift Rate Equations

Definitions for the gyro drift coefficients, NBD, ADIA, ADSRA, and ADOA are given here. It is assumed in the following that the gyro is servo-controlled to maintain the error signal at null.

NBD — The normal excitation bias drift. It is non-acceleration sensitive. NBD is positive when the S. M. drift rate is about the positive gyro input axis (IA). A positive NBD is due to a negative torque about the output axis. The term BD is used to designate gyro bias drift due to mechanical torques present prior to gyro electrical excitation.

ADIA — The acceleration sensitive drift rate due to a gyro case acceleration of one gravity along the input axis. It is positive when the S. M. drift rate is about the positive gyro input axis in response to a positive acceleration along the positive gyro input axis. It will cause a negative torque about the output axis. Internally this term is caused by a displacement of the center of gravity with respect to the center of buoyancy of the float along the positive SRA.

ADSRA — The acceleration sensitive drift rate due to a gyro case acceleration of one gravity along the spin reference axis. It is positive when the S. M. drift rate is about the positive gyro input axis in response to a positive acceleration along the positive gyro SRA. It will cause a negative torque about the output axis. Internally this term is caused

by a displacement of the center of gravity with respect to the center of buoyancy of the float along the minus IA.

ADOA The acceleration sensitive drift rate due to a gyro case acceleration of one gravity along the output axis. It is positive when the S. M. draft rate is about the positive gyro input axis in response to a positive acceleration along the positive gyro OA. The ADOA drift coefficient is generally small relative to the other drift coefficients. There is no computer compensation for the ADOA terms.

The following table gives the drift rates, W_{XSM}, W_{YSM}, W_{ZSM} about the Stable Member axes, XSM, YSM, ZSM respectively due to the various gyro drift coefficients. Figure 7.1 in the next section shows the orientation of the Block II gyro axes relative to the Stable Member axes. (Block I gyro axes have the same orientation with the one exception that the Z gyro IA is along $+Z_{SM}$.) The acceleration components, A_{XSM}, A_{YSM}, A_{ZSM}, are positive with reference to S. M. axes. It is of interest to note that the corresponding drift rate equations for Block I IMUs have the same signs with the exception that NBDZ carries a plus sign.

Drift Rate about S. M. Axes	Gyro Drift Coefficients			
	NBD	ADIA	ADSRA	ADOA
W_{XSM} =	NBDX	+ADIAX(A_{XSM})	-ADSRAX(A_{YSM})	+ADOAX(A_{ZSM})
W_{YSM} =	NBDY	+ADIAY(A_{YSM})	-ADSRAY(A_{ZSM})	+ADOAY(A_{XSM})
W_{ZSM} =	-NBDZ	+ADIAZ(A_{ZSM})	+ADSRAZ(A_{YSM})	+ADOAZ(A_{ZSM})

7.7 Stable Member Axes and Component Orientation Relative to S. M. Axes

IMU Stable Member axes are defined by the following equations:

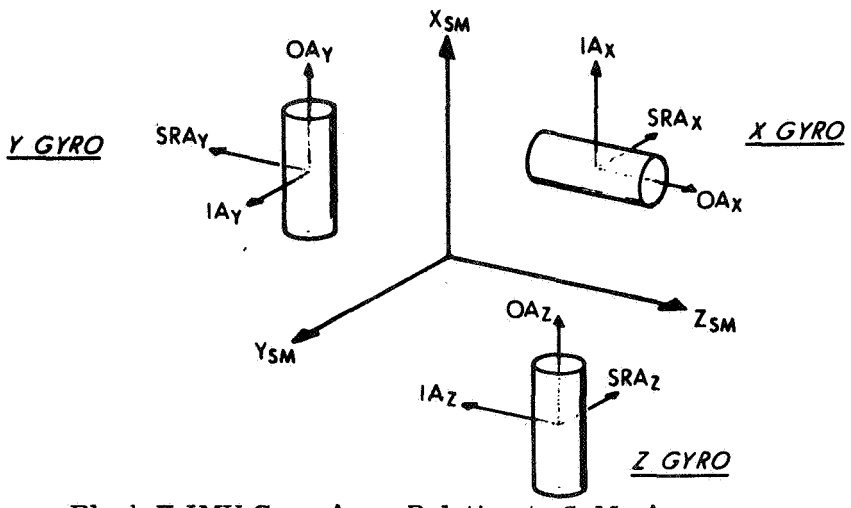
$\bar{YSM}$ = unit ($\bar{IGA}$)

$\bar{ZSM}$ = unit (component of Z_{IA} in plane normal to $\bar{YSM}$)

$\bar{XSM}$ = unit ($\bar{YSM} \times \bar{ZSM}$)

In words YSM is identical with the direction of the IMU Inner Gimbal axis. ZSM is defined by that component of the Z PIPA input axis which lies in the plane perpendicular to YSM.

The orientation of the three S. M. gyros (size - 25 IRIGs) for the Block II IMU system are shown in Figure 7.1 relative to the positive Stable Member axes, XSM, YSM, ZSM.



Block II IMU Gyro Axes Relative to S. M. Axes

Figure 7.1

The following table gives the orientation of gyro axes relative to Stable Member axes.

Gyro	IA Along	SRA Along	OA Along
X	XSM	-YSM	ZSM
Y	YSM	-ZSM	XSM
Z	-ZSM	-YSM	XSM

The input axes of the X, Y, Z accelerometers (PIPAs) lie respectivelv along the positive XSM, YSM, ZSM axes.

7.8 Orientation of Stable Member Axes

The orientations of Stable Member axes prior to the powered trajectories of interest and prior to reentry are defined here.

Prior to the CSM burn for transearth injection as well as for translunar injection the preferred IMU Stable Member orientation is computed as follows:

$\bar{XSM}$ = Unit ($\bar{XCSM}$)

$\bar{YSM}$ = Unit ($\bar{XCSM} \times \bar{R}$)

$\bar{ZSM}$ = Unit ($\bar{XSM} \times \bar{YSM}$)

where

$\bar{XCSM}$ = The CSM X axis at ignition

$\bar{R}$ = the geo centric radius vector at time of ignition

$\bar{YCSM}$ = Unit ($\bar{XCSM} \times \bar{R}$)

by a displacement of the center of gravity with respect to the center of buoyancy of the float along the minus IA.

ADOA The acceleration sensitive drift rate due to a gyro case acceleration of one gravity along the output axis. It is positive when the S. M. draft rate is about the positive gyro input axis in response to a positive acceleration along the positive gyro OA. The ADOA drift coefficient is generally small relative to the other drift coefficients. There is no computer compensation for the ADOA terms.

The following table gives the drift rates, W_{XSM}, W_{YSM}, W_{ZSM} about the Stable Member axes, XSM, YSM, ZSM respectively due to the various gyro drift coefficients. Figure 7.1 in the next section shows the orientation of the Block II gyro axes relative to the Stable Member axes. (Block I gyro axes have the same orientation with the one exception that the Z gyro IA is along $+Z_{SM}$.) The acceleration components, A_{XSM}, A_{YSM}, A_{ZSM}, are positive with reference to S. M. axes. It is of interest to note that the corresponding drift rate equations for Block I IMUs have the same signs with the exception that NBDZ carries a plus sign.

Drift Rate about S. M. Axes	Gyro Drift Coefficients			
	NBD	ADIA	ADSRA	ADOA
W_{XSM} =	NBDX	+ADIAX(A_{XSM})	-ADSRAX(A_{YSM})	+ADOAX(A_{ZSM})
W_{YSM} =	NBDY	+ADIAY(A_{YSM})	-ADSRAY(A_{ZSM})	+ADOAY(A_{XSM})
W_{ZSM} =	-NBDZ	+ADIAZ(A_{ZSM})	+ADSRAZ(A_{YSM})	+ADOAZ(A_{ZSM})

7.7 Stable Member Axes and Component Orientation Relative to S. M. Axes

IMU Stable Member axes are defined by the following equations:

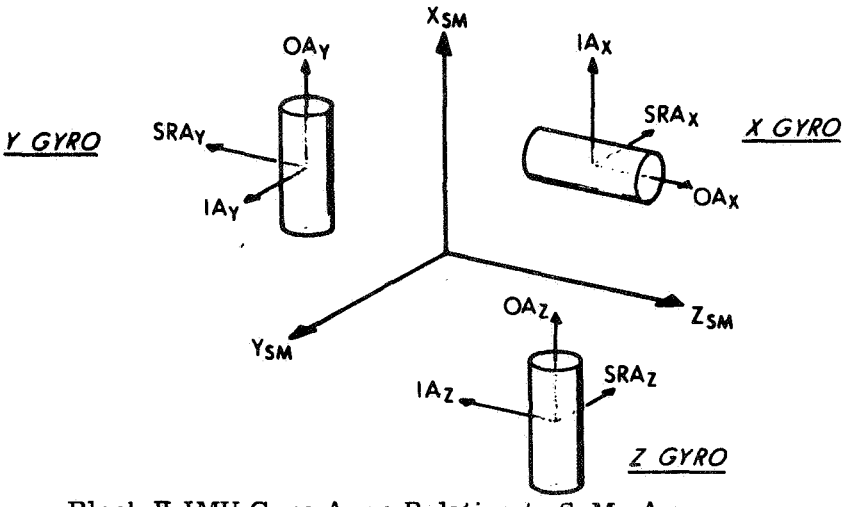
$\bar{YSM}$ = unit ($\bar{IGA}$)

$\bar{ZSM}$ = unit (component of Z_{IA} in plane normal to $\bar{YSM}$)

$\bar{XSM}$ = unit ($\bar{YSM} \times \bar{ZSM}$)

In words YSM is identical with the direction of the IMU Inner Gimbal axis. ZSM is defined by that component of the Z PIPA input axis which lies in the plane perpendicular to YSM.

The orientation of the three S. M. gyros (size - 25 IRIGs) for the Block II IMU system are shown in Figure 7.1 relative to the positive Stable Member axes, XSM, YSM, ZSM.



Block II IMU Gyro Axes Relative to S. M. Axes

Figure 7.1

The following table gives the orientation of gyro axes relative to Stable Member axes.

Gyro	IA Along	SRA Along	OA Along
X	XSM	-YSM	ZSM
Y	YSM	-ZSM	XSM
Z	-ZSM	-YSM	XSM

The input axes of the X, Y, Z accelerometers (PIPAs) lie respectivelv along the positive XSM, YSM, ZSM axes.

7.8 Orientation of Stable Member Axes

The orientations of Stable Member axes prior to the powered trajectories of interest and prior to reentry are defined here.

Prior to the CSM burn for transearth injection as well as for translunar injection the preferred IMU Stable Member orientation is computed as follows:

$\bar{X}SM$ = Unit ($\bar{X}CSM$)

$\bar{Y}SM$ = Unit ($\bar{X}CSM \times \bar{R}$)

$\bar{Z}SM$ = Unit ($\bar{X}SM \times \bar{Y}SM$)

where

$\bar{X}CSM$ = The CSM X axis at ignition

$\bar{R}$ = the geo centric radius vector at time of ignition

$\bar{Y}CSM$ = Unit ($\bar{X}CSM \times \bar{R}$)

It should be noted that all gimbal angles will be zero if the IMU is aligned to the preferred orientation.

In words XSM is oriented in the direction of the thrust vector at ignition time and YSM is oriented normal to the plane formed by XSM and the radius vector.

The orientation equations prior to lunar orbit insertion are the same except for the first one, which is

$$\overline{XSM} = - \text{Unit } (\overline{XCSM})$$

Prior to earth launch the Stable Member is oriented such that YSM and XSM lie in the horizontal plane and ZSM is down, as accomplished by vertical erection. XSM is then oriented to the desired launch azimuth.

Prior to earth reentry the preferred orientation of the Stable Member has not been definitely defined to date. For this error study the following equations for S. M. orientation at reentry start (400, 000 ft altitude) were assumed:

$$\overline{XPK} = - \text{Unit } (\overline{ACCPK})$$
$$\overline{YSM} = \text{Unit } (\overline{XPK} \times \overline{R})$$
$$\overline{ZPK} = \text{Unit } (\overline{YSM} \times \overline{XPK})$$
$$\overline{XSM} = - \text{Unit } (\overline{XPK} + \overline{ZPK})$$
$$\overline{ZSM} = \text{Unit } (\overline{XSM} \times \overline{YSM})$$

where

$\overline{ACCPK}$ is drag acceleration vector at time during reentry when this reaches its peak value.

In other words XSM and ZSM are oriented equi-distant from the peak acceleration vector, while YSM is oriented approximately normal to the initial orbital plane.

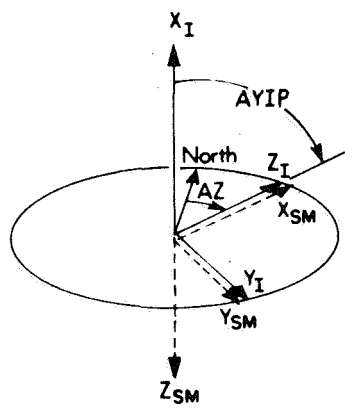
To help the reader visualize the Stable Member orientation prior to the different trajectories, the following table gives the approximate rotation angles required to rotate from local vertical axes at trajectory start to the desired Stable Member orientation. Initially Stable Member axes are colinear with local vertical axes with XSM outward along the local radius vector and ZSM horizontal in the direction of the velocity vector (or reference trajectory plane for earth launch).

S. M. Rotation Angles

Trajectory	About Local Vertical	About YSM
Earth Launch	0	-90°
TLI	0	-94°
LOI	20°	-103°
TEI	3°	-89°
Reentry	0°	-91°

7.9 Stable Member Alignment Errors

Alignment Errors Prior to Earth Launch - These errors caused primarily by (1) the effects of gyro drift on azimuth alignment uncertainty of the IMU Stable Member and (2) the effects of accelerometer uncertainties on vertical erection of the Stable Member. The assumption is here made that gyro-compassing is used to fine-align the Stable Member about azimuth. Figure 7.2 shows the prelaunch S. M. axes in relation to the launch inertial axes (X_I, Y_I, Z_I). X_I is up along the local vertical at time of launch, Z_I is normal to X_I and is oriented to the launch azimuth AZ and Y_I completes a right-handed set.



Stable Member Orientation Prior to Earth Launch
Figure 7.2

Note from the figure that the angle, AYIP, which is the rotation about Y_I of XSM from X_I is -90 degrees here. Note also that a positive misalignment about X_I is equivalent to a negative misalignment about azimuth, since the positive azimuth vector is along $-X_I$. This prelaunch Stable Member orientation will be used for all manned flights, although not for unmanned flights.

Alignment error equations follow. These are grouped under gyrocompassing errors and vertical erection errors. Here the symbol ϕ is used to denote the S. M. misalignment about the inertial vector indicated by the subscript. For example, ϕ_{XI} is the S. M. misalignment about X_I. Note that mlm (AZ) = $-\phi_{XI}$. Second order forms are omitted from the following equations

Prelaunch alignment errors

Gyro-compassing errors

X gyro drift effects

$$\phi_{XI} = NBDX \quad \sin(AZ)/Wh - ADOAX(g) \sin(AZ)/Wh$$

Y gyro drift effects

ϕ_{XI} = NBDY cos (AZ)/Wh + ADSRAY (g) cos (AZ)/Wh

Z gyro drift effects

$\phi_{XI} = 0$

Vertical Erection Errors

ϕ_{YI} = -ACBX/g

ϕ_{ZI} = ACBY/g

where: Wh = WIE cos (Lat) (earth's rate horizontal component)

AZ = azimuth angle measured CW from north.

To use these equations, units must be compatible. For example, if NBD has units of meru, then Wh must have the same units.

Table 7.8 gives the initial misalignments prior to earth launch due to the above error sources for Block II IMU uncertainties.

Alignment Errors Prior to Space Alignment - In the last sub-section equations were given for the orientation of the Stable Member at trajectory start. These alignments are made on the basis of star sightings and CMC computations. There are numerous error sources that influence the accuracy of the fine alignment of the Stable Member. Most significant among these sources are: IMU gimbal resolver functional errors, CDU quantization errors, and misalignment of the sextant relative to the navigation base. A conservative RSS of all these effects on initial misalignment yields 40 secs. initial alignment uncertainty about each S.M. axis.

For all powered trajectories fine alignment is assumed to be completed 15 minutes prior to ignition. (Prior to reentry start the assumed interval is 45 minutes.) If bias drift rate is 2 meru, then the drift angle at ignition time is 0.13 mr (27 secs), which constitutes an initial alignment error. This gyro drift error is assumed to be correlated with the drift error effective during the burn itself.

Table 7.12 is a typical table giving initial alignment errors for the translunar injection trajectory.

7.10 Trajectory Data Used for Error Studies

Error studies for this chapter were made on the basis of trajectory data furnished in the NASA report, "AS-504A Preliminary Spacecraft Reference Trajectory", July 1, 1966 (MSC Internal Note No. 66-FM-70).

The following table summarizes the pertinent trajectory data that have particular meaning for the error studies. Delta V is the integral of thrust acceleration.

Table 7.5
504 Trajectory Data

Trajectory	Duration Secs.	Total ΔV ft/sec.	ΔV in orbit plane ft/sec.	ΔV normal to orbit plane ft/sec.	Peak Acceleration ft/sec^2	Initial Pitch Angle deg.	Initial Yaw Angle deg.
Earth Launch	674	26,785	26,785	0	138	--	--
TLI	343	10,460	10,460	89	48	5.6	- 0.2
LOI	382	3,192	2,917	1,295	10	-13.6	-160.8
TEI	120	2,650	2,648	119	25	1.0	3.4
Reentry	696	34,820	34,814	635	181	--	--

7.11 Earth Launch and Translunar Injection Uncertainty Data

Since Saturn guidance is primary for both the earth launch to orbit and the translunar injection (2nd SIVB burn) trajectories, the data presented here represent uncertainties in monitoring these trajectories.

Earth Launch to Orbit Uncertainties - Tables at the end of this chapter give data on monitoring uncertainties at first SIVB cutoff and at maximum altitude uncertainty point in resulting orbit. These tables are:

7.6 Indication Position & Velocity Uncertainties at Earth Launch Cutoff
7.7 Uncertainties in Flight Path Angle, Velocity Magnitude, etc.
7.8 S. M. Misalignments and Drift Summary
7.9 Indication Uncertainties at Max. Altitude Uncertainty Point in Resulting Orbit After Earth Launch Cutoff

In the computations for the last table (7.9) the effects of venting uncertainties on the orbit were not considered. While the RSS altitude uncertainties are at a maximum for Table 7.9, the altitude uncertainties due to individual IMU uncertainties are not necessarily at a maximum for this particular point in free-fall orbit. A summary of some of the significant uncertainty data follows.

RSS Attitude Uncertainties at Earth Launch Cutoff . . . . . 3,045 ft.
Max. RSS Altitude Uncertainties in Resulting Orbit . . . . 14,454 ft.
RSS Track Uncertainties at Earth Launch Cutoff . . . . . 26,617 ft.

Max. RSS Track Uncertainties in Resulting Orbit	63,910 ft.
Orbit Inclination Uncertainty	0.17 deg.
Increase in Range Uncertainty per Orbit	10.8 n.mi.

Translunar Injection Uncertainties - There are three detailed tables on monitoring uncertainties at translunar injection cutoff (2nd SIVB burn) similar to the first three given for earth launch. These tables include the effects of tracking update uncertainties which were discussed in Section 7.3.

Simulation of translunar injection included the ullage thrust (1200 pounds average) of about 9 secs. duration. According to data received from NASA there is a major venting thrust (140 pounds) that takes place coincidental with ullage start. In parking orbit and prior to ullage start there is continuous venting with an average thrust level of about 14 pounds giving an average acceleration of 0.05 cm/sec^2. Accelerometers are assumed in the error studies to be turned on coincidental with ullage start.

In Table 7.11 data is given in the last column on the approximate velocity correction required at injection plus 8 hours out for each IMU uncertainty. This, of course, assumes that the IMU participates in active guidance (in backup modes) of the spacecraft burn, and is furnished only to help the reader evaluate the significance of the individual IMU uncertainty contributions.

7.12 G&N Uncertainties for CSM Lunar Trajectories and for Reentry

The polarities of the error tables for lunar orbit insertion (LOI), for transearth injection (TEI) and for earth reentry are for errors in actual spacecraft position and velocity minus the nominal position and velocity, where active G&N guidance is assumed.

Lunar Orbit Insertion - Tables at the end of this chapter give detailed uncertainty data for this burn as follows. All but the last table are for LOI cutoff.

7.13 Position and Velocity Uncertainties at LOI Cutoff
7.14 Uncertainties in Flight Path Angle, Velocity Magnitude, etc.
7.15 S.M. Misalignments and Drift Summary
7.16 Uncertainty Covariance Matrices
7.17 Uncertainties at Max. Altitude Uncertainty Point in Resulting Orbit

These tables include the effects of radar tracking update uncertainties. A summary of the significant uncertainty data follows: (These include update uncertainty effects).

RSS Attitude Uncertainties at LOI Cutoff	1,187 ft.
Max. RSS Altitude Uncertainties in Resulting Orbit	12,130 ft.
RSS Track Uncertainties at LOI Cutoff	7,285 ft.
Max. RSS Track Uncertainties in Resulting Orbit	15,005 ft.
Orbit Inclination Uncertainty	0.14 deg.
Increase in Range Uncertainty per Orbit	9.24 n. mi.

It is interesting to note that the maximum RSS altitude uncertainty due to IMU uncertainties is 11,945 feet, although at LOI cutoff it was only 509 feet. The corresponding figures for tracking update uncertainty are 2,100 ft. maximum in orbit and 1,072 ft. at LOI cutoff. This represents a markedly narrower range.

Accelerometer bias is the prime contributor to guidance uncertainty. Initial Stable Member misalignments due to fine alignment uncertainties and to bias drift prior to trajectory start are also important contributors. All other effects are relatively minor. The lunar orbit trajectory simulated for the error studies produced a 5 degree plane change from ignition to cutoff. For that reason Stable Member axes (XSM is along the negative of the initial thrust vector) are not square with the initial free-fall plane.

Transearth Injection Uncertainties - The tables giving error data for TEI cutoff are:

7.18 Position and Velocity Uncertainties
7.19 Uncertainties in Flight Path Angle, Velocity Magnitude, etc.
7.20 S. M. Misalignments and Drift Summary
7.21 Uncertainty Covariance Matrices

These tables include the effects of uncertainties in on-board navigational update using the results of landmark tracking for two lunar orbits. As an alternate procedure update using earth-based radar tracking data, could have been used.

The tables show that the propagated update uncertainties are somewhat larger than those associated with IMU uncertainties. This is primarily because transearth injection is a relatively brief burn (120 seconds), and position and velocity uncertainies due to accelerometer bias (the dominant uncertainty effect) do not have time to get relatively large. The other significant IMU uncertainties are the initial S. M. misalignments due to fine alignment uncertainties and to bias drift prior to burn ignition.

Earth Reentry - The error tables for reentry are for that time when drogue parachute deploys at an altitude of 24,000 feet. These are:

7.22 Uncertainties in Earth Range Coordinates
7.23 Uncertainties in East-North Coordinates

7.24 Uncertainties in Latitude, Longitude, etc.

7.25 S. M. Misalignments and Drift Summary

These tables include the effects of radar tracking update just prior to reentry start at 400,000 ft. altitude.

The first table listed gives data in local vertical-earth range coordinates. The range direction is here defined to be parallel to the ground track of the spacecraft trajectory as viewed by an earth observer. At reentry end the azimuth of the ground track is 118°, whereas the inertial azimuth is about 90°.

Both the first and second tables give position and velocity uncertainty data corresponding to the time when the spacecraft reaches the nominal altitude of 24,000 feet. The third table is furnished primarily to give data on uncertainties in latitude and longitude, also data for elapsed time from altitude at nominal time to nominal altitude.

From these tables we find that: (including update uncertainties)

CEP = 0.79 naut. mile

RSS Lat. Uncert. = 0.0148 deg. = 0.89 mins.

RSS Long. Uncert. = 0.0100 deg. = 0.60 mins.

7.13 Error Computation Procedure

The position, velocity and other uncertainties given in the error tables were computed as follows. Approximate error equations describing the effect of IMU component errors on acceleration indication error were incorporated in a computer program. These equations included the effect of the position error on the computation of gravity. Through two successive integrations errors in indicated trajectory position and velocity could be obtained. The assumptions underlying the use of these equations were: (1) the errors were small relative to the parameters being measured, and (2) the IMU component errors were statistically independent of each other.

Computation of the above errors required as inputs to the main computation program two sets of vectors, one for spacecraft acceleration and the other for its position. These were generated in a separate program where a nominal trajectory was simulated. At significant events, each as powered trajectory cutoff, detailed error printouts could be made.

7.14 Error Table Definitions

Definition of Local Vertical Axes - Many of the error tables give position and velocity uncertainties relative to local vertical coordinate axes (indicated or actual) at nominal event time. These are defined as follows:

Altitude	Outwards along R at event time
Track	Along V × R
Range	Along Altitude × Track

The one exception to the above definitions is the data given for reentry end. There range is defined as parallel to the ground track of the descending spacecraft, and track as perpendicular to the altitude-range plane.

Symbols for IMU Uncertainties

Accelerometer Bias Uncertainty

ACBX	X accelerometer bias, etc.
CM/S. SQ.	centimeters/sec^2

Accelerometer Scale Factor Uncertainty

SFUX	X accelerometer scale factor uncertainty, etc.
PPM	parts per million

Accelerometer Acceleration-Squared Indication Uncertainty

NCXX	X accelerometer accel. squared indic. uncert., etc.
MG/GSQ	micro-gs/g squared

Gyro Bias Drift

NBDXINIT	Effect on initial S. M. misalignment due to 15 minutes X gyro bias drift before trajectory start (45 mins before reentry)
NBDXFLGT	Effect of X gyro drift during powered trajectory or reentry
NBDXCOMB	Total or combined effects of X gyro bias drift
MERU	Milli-earth rate unit = 0.015 deg/hour

Gyro Acceleration Sensitive Drift

ADX-Terms	RSS of uncertainties due to X gyro's ADIAX, ADSRAX, and ADOAX drift uncertainties. Uncertainty values for ADIAX and ADSRAX are given in error tables
MERU/G	Milli-earth rate unit/g = 0.015 deg/hour/g

Gyro Acceleration Squared Sensitive Drift

ADIXX	X gyro acceleration-squared sensitive drift due to acceleration along its input axis
ADSYY	Y gyro acceleration-squared sensitive drift due to acceleration along its spin reference axis
ACIZZ	Z gyro acceleration-squared sensitive drift due to acceleration along its input axis
MERU/GSQ	Milli-earth rate unit/g^2 = 0.015 deg/hour/g^2

Error Tables

7.6 Position and Velocity Uncertainties at Earth Launch Cutoff
7.7 Other Uncertainties at Earth Launch Cutoff
7.8 S. M. Misalignments and Drift Angles at Earth Launch Cutoff
7.9 Uncertainties at Max. Altitude Uncertainty Point in Orbit After Earth Launch Cutoff
7.10 Position and Velocity Uncertainties at TLI Cutoff
7.11 Other Uncertainties at TLI Cutoff
7.12 S. M. Misalignments and Drift Angles at TLI Cutoff
7.13 Position and Velocity Uncertainties at LOI Cutoff
7.14 Other Uncertainties at LOI Cutoff
7.15 S. M. Misalignments and Drift Angles at LOI Cutoff
7.16 Uncertainty Covariance Matrices at LOI Cutoff
7.17 Uncertainties at Max. Altitude Uncertainty Point in Orbit After LOI Cutoff
7.18 Position and Velocity Uncertainties at TEI Cutoff
7.19 Other Uncertainties at TEI Cutoff
7.20 S. M. Misalignments and Drift Angles at TEI Cutoff
7.21 Uncertainty Covariance Matrices at TEI Cutoff
7.22 Position and Velocity Uncertainties at Reentry End
7.23 Position and Velocity Uncertainties at Reentry End (East-North Axes)
7.24 Other Uncertainties at Reentry End
7.25 S. M. Misalignments and Drift Angles at Reentry End

CONFIDENTIAL

POSITION AND VELOCITY UNCERTAINTIES ALONG LOCAL AXES AT TIME FROM LAUNCH = 0 HR. 11 MIN. 13.840 SEC (673.840 SEC)

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	POSITION UNCERTAINTIES IN FEET (REL.TO INDIC.AXES AT NOM.TIME) ALT.	TRACK	RANGE	VELOCITY UNCERTAINTIES IN FT/SEC (REL.TO INDIC.AXES AT NOM.TIME) ALT.	TRACK	RANGE
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED) ABOUT LAUNCH INERTIAL AXES							
ABOUT XI	50.0 SECS	-26.2	-2074.7	-23.1	-0.107	-5.370	-0.059
ABOUT YI	5.0 SECS	161.8	0.8	-212.3	0.319	0.000	-0.414
ABOUT ZI	5.0 SECS	1.7	130.6	1.4	0.005	0.181	0.002
ACCELEROMETER INPUT AXIS MISALIGNMENTS							
X ABOUT Y	0.0 SECS	0.0	0.0	0.0	0.000	0.000	0.000
X ABOUT Z	20.0 SECS	0.0	0.0	0.0	0.000	0.000	0.000
Y ABOUT X	0.0 SECS	0.0	0.0	0.0	0.000	0.000	0.000
Y ABOUT Z	20.0 SECS	10.5	829.9	9.3	0.043	2.148	0.024
Z ABOUT X	28.3 SECS	0.0	0.0	0.0	0.000	0.000	0.000
Z ABOUT Y	28.3 SECS	1254.9	-6.7	-536.1	3.264	-0.018	-1.440
ACCEL.BIAS (INIT.EARTH LAUNCH S.M. MLMS. - DUE TO ACBY 0.204 MR.ABOUT ZSM, DUE TO ACBZ 0.000 MR.ABOUT YSM)							
ACBXINIT		-1361.3	-6.6	1786.3	-2.687	0.003	3.486
ACBXFLGT	0.200 CM/S.SQ	-657.1	22.2	-1319.6	-3.645	-0.061	-3.610
ACBXCOMB		-2018.4	15.5	466.7	-6.332	0.064	-0.124
ACBYINIT		14.5	1098.6	12.1	0.044	1.526	0.016
ACBYFLGT	0.200 CM/S.SQ	-18.5	-1462.0	-16.3	-0.078	-4.020	-0.044
ACBYCOMB		-4.1	-363.4	-4.2	-0.034	-2.494	-0.029
ACBZINIT		0.0	0.0	0.0	0.000	0.000	0.000
ACBZFLGT	0.200 CM/S.SQ	1579.9	-8.4	-673.9	4.317	-0.023	-1.905
ACBZCOMB		1579.9	-8.4	-673.9	4.317	-0.023	-1.905
ACCELEROMETER SCALE FACTOR UNCERTAINTIES							
SFUX	116 PPM	445.5	-15.0	896.3	2.407	-0.039	2.307
SFUY	116 PPM	0.0	0.0	0.0	0.000	0.000	0.000
SFUZ	116 PPM	728.4	-3.7	304.4	1.249	-0.005	-0.505
GYRO BIAS DRIFT (INIT.EARTH LCH.S.M.MLMS.ABT.XI - DUE TO BDX 2.163 MR., DUE TO BDY 0.703 MR., DUE TO BDZ 0.146 MR.)							
NBDXINIT	2.0 MERU	-226.3	-18515.1	-206.4	-0.919	-47.926	-0.526
NBDXFLGT	(0.100 MR.DRIFT	1.1	87.6	1.0	0.003	0.093	0.001
NBDXCOMB	SINCE LAUNCH)	-225.2	-18427.5	-205.5	-0.916	-47.833	-0.525
NBDYINIT	2.0 MERU	-75.3	-6015.9	-67.1	-0.308	-15.572	-0.171
NBDYFLGT	(0.100 MR.DRIFT	268.4	-0.4	213.0	0.912	-0.005	-0.572
NBDYCOMB	SINCE LAUNCH)	193.2	-6016.2	280.1	0.604	-15.576	-0.743
NBDZINIT	2.0 MERU	-15.8	-1248.2	-13.9	-0.065	-3.231	-0.035
NBDZFLGT	(0.100 MR.DRIFT	-3.8	-304.0	-3.4	-0.019	-1.102	-0.012
NBDZCOMB	SINCE LAUNCH)	-19.5	-1552.2	-17.3	-0.083	-4.333	-0.048
GYRO ACCELERATION SENSITIVE DRIFT (RSS OF UNCERTAINTIES DUE TO ADIA, ADSRA, AND ADOA DRIFT UNCERTAINTIES FOR EACH GYRO)							
ADX-TERMS	8.0, 5.0 MERU/G	118.3	9204.7	102.6	0.488	23.879	0.262
ADY-TERMS	8.0, 5.0 MERU/G	504.1	15039.2	784.9	1.118	38.935	1.871
ADZ-TERMS	8.0, 5.0 MERU/G	48.2	3772.6	42.0	0.193	9.340	0.102
GYRO ACCELERATION SQUARED SENSITIVE DRIFT							
ADIXX	0.2 MERU/GSQ	0.2	16.7	0.2	0.001	0.019	0.000
ADSYY	0.2 MERU/GSQ	37.4	0.0	-35.5	0.091	0.000	-0.080
ADIZZ	0.2 MERU/GSQ	-0.6	-43.3	-0.5	-0.002	-0.122	-0.001
RSS UNCERT.(FT AND FT/SEC)		3045.2	26516.9	1634.6	8.930	69.011	3.998
RSS UNCERT.(N.MI.AND FT/SEC)		0.501	4.380	0.269	8.930	69.011	3.998

TABLE 7.6 POSITION AND VELOCITY UNCERTAINTIES AT EARTH LAUNCH CUTOFF

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UNCERTAINTIES IN (AT TIME = 0 HR, 11 MIN, 13.840 SEC (673.840 SECS))

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	INERTIAL FLIGHT PATH ANGLE (DEG)	INERTIAL VELOCITY (FT/SEC)	INERTIAL AZIMUTH (DEG)	ORBIT INCLIN. (DEG)	LATITUDE (DEG)	LONGITUDE (DEG)	ALT.AT PERIGEE (FEET)
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED)								
ABOUT XI	50.0 SECS	0.0002	0.0595	0.0120	0.0132	-0.0055	0.0004	29.55
ABOUT YI	5.0 SECS	-0.0007	0.4143	0.0000	0.0000	0.0000	0.0007	-171.04
ABOUT ZI	5.0 SECS	0.0000	-0.0018	-0.0004	-0.0005	0.0003	0.0000	-1.88
ACCELEROMETER INPUT AXIS MISALIGNMENTS								
X ABOUT Y	0.0 SECS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
X ABOUT Z	20.0 SECS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
Y ABOUT X	0.0 SECS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
Y ABOUT Z	20.0 SECS	-0.0001	-0.0235	-0.0048	-0.0053	0.0022	-0.0001	-11.82
Z ABOUT X	28.3 SECS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
Z ABOUT Y	28.3 SECS	-0.0073	1.4402	0.0000	0.0000	0.0000	0.0017	-1352.00
ACCELEROMETER BIAS								
ACBXINIT		0.0060	-3.4854	0.0000	0.0000	-0.0002	-0.0056	1439.08
ACBXFLGT	0.200 CM/S.SQ	0.0082	3.6102	-0.0001	-0.0001	0.0002	0.0042	770.59
ACBXCOMB		0.0142	0.1251	-0.0001	-0.0001	0.0000	-0.0015	2209.67
ACBYINIT		-0.0001	-0.0156	-0.0034	-0.0045	0.0029	-0.0002	-15.85
ACBYFLGT	0.200 CM/S.SQ	0.0002	0.0445	0.0090	0.0098	-0.0039	0.0003	20.98
ACBYCOMB		0.0001	0.0286	0.0056	0.0057	-0.0010	0.0001	5.13
ACBZINIT		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
ACBZFLGT	0.200 CM/S.SQ	-0.0097	1.9058	0.0001	0.0001	0.0001	0.0021	-1708.26
ACBZCOMB		-0.0097	1.9058	0.0001	0.0001	0.0001	0.0021	-1708.26
ACCELEROMETER SCALE FACTOR UNCERTAINTIES								
SFUX	116.0 PPM	-0.0054	-2.3067	0.0001	0.0001	-0.0001	-0.0028	-520.42
SFUY	116.0 PPM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
SFUZ	116.0 PPM	-0.0028	0.5047	0.0000	0.0000	0.0000	0.0010	-765.78
GYRO BIAS DRIFT								
NBDXINIT		0.0022	0.5710	0.1074	0.1181	-0.0492	0.0033	263.68
NBDXFLGT	2.0 MERU	0.0000	-0.0009	-0.0002	-0.0003	0.0002	0.0000	-1.23
NBDXCOMB		0.0022	0.5699	0.1072	0.1178	-0.0490	0.0033	262.45
NBDYINIT		0.0007	0.1757	0.0349	0.0384	-0.0160	0.0011	85.67
NBDYFLGT	2.0 MERU	-0.0020	0.5717	0.0000	0.0000	0.0000	0.0007	-295.34
NBDYCOMB		-0.0013	0.7474	0.0349	0.0384	-0.0160	0.0017	-209.67
NBDZINIT		0.0001	0.0357	0.0072	0.0080	-0.0033	0.0002	17.78
NBDZFLGT	2.0 MERU	0.0000	0.0124	0.0025	0.0026	-0.0008	0.0001	4.32
NBDZCOMB		0.0002	0.0482	0.0097	0.0106	-0.0041	0.0003	22.09
GYRO ACCELERATION SENSITIVE DRIFT (RSS OF UNCERTAINTIES DUE TO ADIA, ADSRA AND ADOA UNCERTAINTIES FOR EACH GYRO)								
ADX-TERMS 8.0, 5.0 MERU/G		0.0010	0.2510	0.0535	0.0588	0.0244	0.0016	131.08
ADY-TERMS 8.0, 5.0 MERU/G		0.0023	1.9002	0.0872	0.0960	0.0399	0.0046	529.57
ADZ-TERMS 8.0, 5.0 MERU/G		0.0004	0.1004	0.0209	0.0232	0.0100	0.0007	53.80
RSS UNCERTAINTIES		0.0200	4.0188	0.1546	0.1701	0.0707	0.0076	3308.52

TABLE 7.7 OTHER UNCERTAINTIES AT EARTH LAUNCH CUTOFF

INITIAL S.M.MLMS. AND DRIFT ANGLES SUMMARY (S.M.ANGLES AXI= 0.000, AYPI=- 90.000, AZSM= 0.000 DEG)(T= 673.840 SEC)

UNCERT. SOURCE	ONE SIGMA UNCERT.VALUE		MLM. ANGLE ABOUT STABLE MEMBER AXES XSM	YSM	ZSM	MLM.ANGLE ABOUT LOCAL VERTICAL AXES ALT.	MR. TRACK	RANGE
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED WITH ALIGNMENT UNCERT.DUE TO LISTED GYRO AND PIPA UNCERT.) ABOUT								
ABOUT XI	50	SECS	0.0000	0.0000	- 0.2424	0.2202	- 0.0013	- 0.1013
ABOUT YI	5	SECS	0.0000	0.0242	0.0000	0.0002	0.0242	0.0002
ABOUT ZI	5	SECS	0.0242	0.0000	0.0000	0.0101	- 0.0003	0.0220
INITIAL S.M. MLMS. DUE TO IMU ERROR EFFECTS ON EARTH LAUNCH ERECTION AND ALIGNMENT								
ACBX	0.200	CM/S.SQ	0.0000	- 0.2039	0.0000	- 0.0023	- 0.2039	- 0.0023
ACBY	0.200	CM/S.SQ	0.2039	0.0000	0.0000	0.0852	- 0.0030	0.1852
ACBZ	0.200	CM/S.SQ	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
NBDX	2.0	MERU	0.0000	0.0000	- 2.1633	1.9652	- 0.0121	- 0.9041
NBDY	2.0	MERU	0.0000	0.0000	- 0.7029	0.6385	- 0.0039	- 0.2937
NBDZ	2.0	MERU	0.0000	0.0000	- 0.1458	0.1324	- 0.0008	- 0.0609
ADIAX	8.0	MERU/S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ADSRAX	5.0	MERU/S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ADOAX	1.0	MERU/S	0.0000	0.0000	1.0816	- 0.9826	0.0060	0.4520
ADIAY	8.0	MERU/S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ADSRAY	5.0	MERU/S	0.0000	0.0000	- 1.7572	1.5963	- 0.0098	- 0.7344
ADOAY	1.0	MERU/S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ADIAZ	8.0	MERU/S	0.0000	0.0000	0.5833	- 0.5299	0.0032	0.2438
ADSRAZ	5.0	MERU/S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ADOAZ	1.0	MERU/S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
RSS INITIAL S.M. MLMS.			0.2053	0.2053	3.1388	2.8527	0.2061	1.3251
DRIFT ANGLES DUE TO GYRO DRIFT AFTER TRAJECTORY START								
NBDX	2.0	MERU	0.1001	0.0000	0.0000	0.0418	- 0.0015	0.0909
NBDY	2.0	MERU	0.0000	0.1001	0.0000	0.0011	0.1001	0.0011
NBDZ	2.0	MERU	0.0000	0.0000	- 0.1001	0.0909	- 0.0005	- 0.0418
ADIAX	8.0	MERU/S	0.4520	0.0000	0.0000	0.1888	- 0.0068	0.4106
ADSRAX	5.0	MERU/S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ADOAX	1.0	MERU/S	- 0.0221	0.0000	0.0000	- 0.0092	0.0003	- 0.0201
ADIAY	8.0	MERU/S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ADSRAY	5.0	MERU/S	0.0000	0.1109	0.0000	0.0012	0.1109	0.0012
ADOAY	1.0	MERU/S	0.0000	0.0565	0.0000	0.0006	0.0564	0.0006
ADIAZ	8.0	MERU/S	0.0000	0.0000	- 0.1775	0.1613	- 0.0009	- 0.0742
ADSRAZ	5.0	MERU/S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ADOAZ	1.0	MERU/S	0.0000	0.0000	- 0.0565	0.0513	- 0.0003	- 0.0236
RSS DRIFT ANGLE			0.4638	0.1599	0.2116	0.2730	0.1600	0.4305
OVERALL RSS MLM			0.5073	0.2603	3.1459	2.8657	0.2609	1.3932

TABLE 7.8 S.M. MISALIGNMENTS AND DRIFT ANGLES AT EARTH LAUNCH CUTOFF

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POSITION AND VELOCITY UNCERTAINTIES ALONG LOCAL AXES AT TIME FROM LAUNCH = 0 HR, 43 MIN, 29.692 SEC (2609.692 SEC)

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	POSITION UNCERTAINTIES IN FEET (REL.TO INDIC.AXES AT NOM.TIME) ALT.	TRACK	RANGE	VELOCITY UNCERTAINTIES IN FT/SEC (REL.TO INDIC.AXES AT NOM.TIME) ALT.	TRACK	RANGE
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED) ABOUT LAUNCH INERTIAL AXES							
ABOUT XI	50.0 SECS	-303.1	-1999.2	614.2	-0.041	5.407	0.269
ABOUT YI	5.0 SECS	-529.2	-0.7	-619.6	-0.687	0.000	0.406
ABOUT ZI	5.0 SECS	13.1	27.3	-28.7	0.001	-0.236	-0.012
ACCELEROMETER INPUT AXIS MISALIGNMENTS							
X ABOUT Y	0.0 SECS	0.0	0.0	0.0	0.000	0.000	0.000
X ABOUT Z	20.0 SECS	0.0	0.0	0.0	0.000	0.000	0.000
Y ABOUT X	0.0 SECS	0.0	0.0	0.0	0.000	0.000	0.000
Y ABOUT Z	20.0 SECS	121.3	799.7	-245.7	0.016	-2.163	-0.108
Z ABOUT X	28.3 SECS	0.0	0.0	0.0	0.000	0.000	0.000
Z ABOUT Y	28.3 SECS	1370.3	-6.6	-11734.4	-3.192	0.018	-1.562
ACCEL.BIAS (INIT.EARTH LAUNCH S.M. MLMS. - DUE TO ACBY 0.204 MR.ABOUT ZSM, DUE TO ACBZ 0.000 MR.ABOUT YSM)							
ACBXINIT		4452.4	6.2	5211.9	5.776	0.004	-3.418
ACBXFLGT	0.200 CM/S.SQ	-14165.4	23.6	24344.3	-3.546	-0.060	12.440
ACBXCOMB		-9707.1	29.9	29554.7	2.228	-0.056	9.023
ACBYINIT		110.4	229.3	-241.7	0.007	-1.988	-0.098
ACBYFLGT	0.200 CM/S.SQ	-223.0	-1557.1	449.9	-0.031	3.967	0.198
ACBYCOMB		-112.6	-1327.7	208.1	-0.024	1.979	0.100
ACBZINIT		0.0	0.0	0.0	0.000	0.000	0.000
ACBZFLGT	0.200 CM/S.SQ	1597.4	-9.0	-15049.0	-4.294	0.023	-1.905
ACBZCOMB		1597.4	-9.0	-15049.0	-4.294	0.023	-1.905
ACCELEROMETER SCALE FACTOR UNCERTAINTIES							
SFUX	116 PPM	9183.4	-14.5	-15842.4	2.272	0.039	-8.036
SFUY	116 PPM	0.0	0.0	0.0	0.000	0.000	0.000
SFUZ	116 PPM	1316.2	-0.9	-6081.9	-0.930	0.007	-1.196
GYRO BIAS DRIFT (INIT.EARTH LCH.S.M.MLMS.ABT.XI - DUE TO BDX 2.163 MR., DUE TO BDY 0.703 MR., DUE TO BDZ 0.146 MR.)							
NBDXINIT	2.0 MERU	-2697.8	-17843.1	5482.1	-0.400	48.253	2.404
NBDXFLGT	(0.382 MR.DRIFT	7.6	0.3	-17.0	0.000	-0.140	-0.007
NBDXCOMB	SINCE LAUNCH)	-2690.2	-17842.8	5465.1	-0.400	48.113	2.397
NBDYINIT	2.0 MERU	-878.4	-5797.1	1781.1	-0.122	15.678	0.781
NBDYFLGT	(0.382 MR.DRIFT	-312.4	-2.8	-2340.9	-1.219	0.004	0.120
NBDYCOMB	SINCE LAUNCH)	-1190.9	-5800.0	-559.9	-1.341	15.682	0.900
NBDZINIT	2.0 MERU	-182.4	-1202.8	369.5	-0.025	3.253	0.162
NBDZFLGT	(0.382 MR.DRIFT	-56.5	-491.5	110.4	-0.009	1.002	0.050
NBDZCOMB	SINCE LAUNCH)	-238.9	-1694.3	479.9	-0.034	4.255	0.212
GYRO ACCELERATION SENSITIVE DRIFT (RSS OF UNCERTAINTIES DUE TO ADIA, ADSRA, AND ADOA DRIFT UNCERTAINTIES FOR EACH GYRO)							
ADX-TERMS	8.0, 5.0 MERU/G	1349.2	8905.0	2728.2	0.171	24.023	1.196
ADY-TERMS	8.0, 5.0 MERU/G	3311.2	14498.5	1475.2	3.068	39.198	2.651
ADZ-TERMS	8.0, 5.0 MERU/G	535.5	3369.1	1090.1	0.068	9.549	0.475
GYRO ACCELERATION SQUARED SENSITIVE DRIFT							
ADIXX	0.2 MERU/GSQ	1.5	1.2	-3.3	0.000	-0.028	-0.001
ADSYY	0.2 MERU/GSQ	-65.6	-0.2	-232.3	-0.146	0.000	0.043
ADIZZ	0.2 MERU/GSQ	-6.7	-47.9	13.4	-0.001	0.119	0.006
RSS UNCERT.(FT AND FT/SEC)		14442.3	25732.0	39665.6	7.184	69.438	13.051
RSS UNCERT.(N.MI.AND FT/SEC)		2.376	4.234	6.528	7.184	69.438	13.051

TABLE 7.9 UNCERTAINTIES AT MAX. ALTITUDE UNCERTAINTY POINT IN ORBIT AFTER EARTH LAUNCH CUTOFF

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POSITION AND VELOCITY UNCERTAINTIES ALONG LOCAL AXES AT TIME = 0 HR. 5 MIN. 43.060 SECS (343.060 SECS)

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	POSITION UNCERTAINTIES IN FEET (REL.TO INDIC.AXES AT NOM.TIME) ALT.	TRACK	RANGE	VELOCITY UNCERTAINTIES IN FT/SEC (REL.TO INDIC.AXES AT NOM.TIME) ALT.	TRACK	RANGE
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED WITH GYRO DRIFT ANGLES) ABOUT STABLE MEMBER AXES							
ABOUT XSM	40.0 SECS	1.8	23.1	0.7	0.017	0.263	0.007
ABOUT YSM	40.0 SECS	-286.3	-0.3	94.9	-1.885	-0.002	0.523
ABOUT ZSM	40.0 SECS	-0.9	290.6	-1.4	-0.011	1.909	-0.015
ACCELEROMETER INPUT AXIS MISALIGNMENTS							
X ABOUT Y	28.3 SECS	-6.5	0.0	-15.0	-0.100	0.000	-0.171
X ABOUT Z	20.0 SECS	0.4	0.0	0.9	0.005	0.000	0.008
Y ABOUT X	20.0 SECS	0.0	11.6	0.0	0.000	0.131	0.000
Y ABOUT Z	20.0 SECS	0.1	-145.3	-0.2	0.000	-0.954	-0.001
Z ABOUT X	20.0 SECS	0.9	0.0	-0.4	0.008	0.000	-0.004
Z ABOUT Y	0.0 SECS	0.0	0.0	0.0	0.000	0.000	0.000
ACCELEROMETER BIAS							
ACBX	0.200 CM/S.SQ	152.7	-0.3	349.8	1.472	-0.002	1.938
ACBY	0.200 CM/S.SQ	-0.2	380.9	0.4	-0.001	2.112	0.002
ACBZ	0.200 CM/S.SQ	-365.4	-0.4	152.8	-1.942	-0.002	0.852
ACCELEROMETER SCALE FACTOR UNCERTAINTIES							
SFUX	116.0 PPM	-69.6	0.1	-159.7	-0.740	0.001	-1.048
SFUY	116.0 PPM	0.0	-1.1	0.0	0.000	-0.011	0.000
SFUZ	116.0 PPM	12.9	0.0	-5.5	0.142	0.000	-0.062
GYRO BIAS DRIFT (15 MIN.DRIFT TIME BEFORE TRAJ.START RESULTING IN 0.131 MR. INITIAL MLM. ABOUT EACH S.M. AXIS)							
NBDXINIT	2.0 MERU	1.2	15.6	-0.5	0.011	0.178	-0.005
NBDXFLGT	(0.050 MR.DRIFT	0.2	3.4	-0.1	0.003	0.051	-0.001
NBDXCOMB	SINCE TRAJ.START)	1.4	19.0	-0.6	0.014	0.229	-0.006
NBDYINIT	2.0 MERU	-193.7	-0.2	64.2	-1.276	-0.001	0.354
NBDYFLGT	(0.050 MR.DRIFT	-29.1	0.0	8.6	-0.287	0.000	0.067
NBDYCOMB	SINCE TRAJ.START)	-222.8	-0.2	72.8	-1.563	-0.001	0.421
NBDZINIT	2.0 MERU	-0.6	196.7	-1.0	-0.007	1.292	-0.010
NBDZFLGT	(0.050 MR.DRIFT	-0.1	29.5	-0.2	-0.002	0.288	-0.003
NBDZCOMB	SINCE TRAJ.START)	-0.8	226.2	-1.2	-0.009	1.580	-0.013
GYRO ACCELERATION SENSITIVE DRIFT							
ADX-TERMS	8.0, 5.0 MERU/G	0.7	10.8	0.3	0.010	0.176	0.004
ADY-TERMS	8.0, 5.0 MERU/G	11.4	0.0	3.3	0.129	0.000	0.028
ADZ-TERMS	8.0, 5.0 MERU/G	0.1	12.3	0.1	0.001	0.143	0.001
GYRO ACCELERATION SQUARED SENSITIVE DRIFT							
ADIXX	0.2 MERU/GSQ	0.0	0.2	0.0	0.000	0.004	0.000
ADSYY	0.2 MERU/GSQ	0.0	0.0	0.0	0.000	0.000	0.000
ADIZZ	0.2 MERU/GSQ	0.0	0.0	0.0	0.000	0.000	0.000
RSS UNCERT.(FT AND FT/SEC)		541.8	550.5	431.2	3.540	3.421	2.464
RSS TKG.UPDATE UNCERT.		784.1	386.0	6847.3	3.172	0.261	0.447
OVERALL RSS UNCERTAINTIES		953.1	672.4	6860.9	4.754	3.431	2.504

TABLE 7.10 POSITION AND VELOCITY UNCERTAINTIES AT TLI CUTOFF

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UNCERTAINTIES IN (AT TIME = 0 HR, 5 MIN, 43.060 SEC (343.060 SECS))

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	INERTIAL FLIGHT PATH ANGLE (DEG)	INERTIAL VELOCITY (FT/SEC)	INERTIAL AZIMUTH (DEG)	FREE FALL TIME TO NOM. ALT. (SECS)	LATITUDE (DEG)	LONGITUDE (DEG)	VELOC.CORR. AT TLI+8 HR (FT/SEC)
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED)								
ABOUT XSM	40.0 SECS	0.0000	-0.0048	0.0004	-0.0004	-0.0001	0.0000	-0.01
ABOUT YSM	40.0 SECS	-0.0031	0.2780	0.0000	0.0629	0.0001	0.0002	0.50
ABOUT ZSM	40.0 SECS	0.0000	-0.0161	0.0031	0.0002	-0.0006	0.0004	-0.09
ACCELEROMETER INPUT AXIS MISALIGNMENTS								
X ABOUT Y	28.3 SECS	-0.0001	-0.1822	0.0000	0.0014	0.0000	0.0000	1.02
X ABOUT Z	20.0 SECS	0.0000	0.0090	0.0000	-0.0001	0.0000	0.0000	-0.05
Y ABOUT X	20.0 SECS	0.0000	0.0001	0.0002	0.0000	0.0000	0.0000	-0.01
Y ABOUT Z	20.0 SECS	0.0000	-0.0010	-0.0015	0.0000	0.0003	-0.0002	0.10
Z ABOUT X	20.0 SECS	0.0000	-0.0026	0.0000	-0.0002	0.0000	0.0000	0.01
Z ABOUT Y	0.0 SECS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.10
ACCELEROMETER BIAS								
ACBXINIT		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
ACBXFLGT	0.200 CM/S.SQ	0.0019	2.1098	0.0000	-0.0335	0.0005	0.0008	-12.18
ACBXCOMB		0.0019	2.1098	0.0000	-0.0335	0.0005	0.0008	-12.18
ACBYINIT		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
ACBYFLGT	0.200 CM/S.SQ	0.0000	0.0022	0.0034	0.0001	-0.0008	0.0005	-0.22
ACBYCOMB		0.0000	0.0022	0.0034	0.0001	-0.0008	0.0005	-0.22
ACBZINIT		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
ACBZFLGT	0.200 CM/S.SQ	-0.0033	0.5972	0.0000	0.0802	0.0002	0.0003	-0.80
ACBZCOMB		-0.0033	0.5972	0.0000	0.0802	0.0002	0.0003	-0.80
ACCELEROMETER SCALE FACTOR UNCERTAINTIES								
SFUX	116.0 PPM	-0.0010	-1.1340	0.0000	0.0153	-0.0002	-0.0004	6.49
SFUY	116.0 PPM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
SFUZ	116.0 PPM	0.0002	-0.0435	0.0000	-0.0028	0.0000	0.0000	0.12
GYRO BIAS DRIFT								
NBDXINIT		0.0000	-0.0033	0.0003	-0.0003	0.0000	0.0000	-0.01
NBDXFLGT	2.0 MERU	0.0000	-0.0009	0.0001	0.0000	0.0000	0.0000	0.00
NBDXCOMB		0.0000	-0.0042	0.0004	-0.0003	0.0000	0.0000	-0.01
NBDYINIT		-0.0021	0.1881	0.0000	0.0425	0.0001	0.0001	0.34
NBDYFLGT	2.0 MERU	-0.0005	0.0300	0.0000	0.0064	0.0000	0.0000	0.08
NBDYCOMB		-0.0026	0.2181	0.0000	0.0489	0.0001	0.0002	0.41
NBDZINIT		0.0000	-0.0109	0.0021	0.0001	-0.0004	0.0003	-0.06
NBDZFLGT	2.0 MERU	0.0000	-0.0030	0.0005	0.0000	-0.0001	0.0000	-0.01
NBDZCOMB		0.0000	-0.0139	0.0026	0.0002	-0.0005	0.0003	-0.07
GYRO ACCELERATION SENSITIVE DRIFT (RSS OF UNCERTAINTIES DUE TO ADIA, ADSRA AND ADOA UNCERTAINTIES FOR EACH GYRO)								
ADX-TERMS	8.0, 5.0 MERU/G	0.0000	0.0030	0.0003	0.0002	0.0000	0.0000	0.01
ADY-TERMS	8.0, 5.0 MERU/G	0.0002	0.0118	0.0000	0.0025	0.0000	0.0000	0.03
ADZ-TERMS	8.0, 5.0 MERU/G	0.0000	0.0016	0.0002	0.0000	0.0000	0.0000	0.00
RSS UNCERTAINTIES		0.0056	2.5028	0.0055	0.1190	0.0014	0.0012	13.89

TABLE 7.11 OTHER UNCERTAINTIES AT TLI CUTOFF

INITIAL S.M.MLMS. AND DRIFT ANGLES SUMMARY (S.M.ANGLES AXI= 179.849, AYPI=- 86.000, AZSM= 179.999 DEG)(T= 343.060 SEC)

UNCERT. SOURCE	ONE SIGMA UNCERT.VALUE	MLM. ANGLE ABOUT STABLE MEMBER AXES XSM	MR. YSM	ZSM	MLM.ANGLE ABOUT LOCAL VERTICAL AXES ALT.	MR. TRACK	RANGE
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED WITH GYRO DRIFT ANGLES) ABOUT							
ABOUT XSM	40 SECS	0.1939	0.0000	0.0000	0.0761	- 0.0001	0.1783
ABOUT YSM	40 SECS	0.0000	0.1939	0.0000	- 0.0001	0.1939	0.0002
ABOUT ZSM	40 SECS	0.0000	0.0000	0.1939	- 0.1783	- 0.0001	0.0761
INITIAL S.M. MLMS. AT TRAJ. START DUE TO GYRO BIAS DRIFT FOR 15 MINS. PRIOR TO START OF TRAJECTORY							
NBDX	2.0 MERU	0.1312	0.0000	0.0000	0.0515	- 0.0000	0.1207
NBDY	2.0 MERU	0.0000	0.1312	0.0000	- 0.0000	0.1312	0.0001
NBDZ	2.0 MERU	0.0000	0.0000	0.1312	- 0.1207	- 0.0001	0.0515
RSS INITIAL S.M. MLMS.		0.2341	0.2341	0.2341	0.2341	0.2341	0.2341
DRIFT ANGLES DUE TO GYRO DRIFT AFTER TRAJECTORY START							
NBDX	2.0 MERU	0.0500	0.0000	0.0000	0.0196	- 0.0000	0.0460
NBDY	2.0 MERU	0.0000	0.0500	0.0000	- 0.0000	0.0500	0.0000
NBDZ	2.0 MERU	0.0000	0.0000	- 0.0500	0.0460	0.0000	- 0.0196
ADIAX	8.0 MERU/G	0.1879	0.0000	0.0000	0.0738	- 0.0001	0.1728
ADSRAX	5.0 MERU/G	- 0.0011	0.0000	0.0000	- 0.0004	0.0000	- 0.0010
ADOAX	1.0 MERU/G	0.0031	0.0000	0.0000	0.0012	- 0.0000	0.0029
ADIAY	8.0 MERU/G	0.0000	0.0017	0.0000	- 0.0000	0.0017	0.0000
ADSRAY	5.0 MERU/G	0.0000	- 0.0157	0.0000	0.0000	- 0.0157	- 0.0000
ADOAY	1.0 MERU/G	0.0000	0.0234	0.0000	- 0.0000	0.0234	0.0000
ADIAZ	8.0 MERU/G	0.0000	0.0000	0.0252	- 0.0232	- 0.0000	0.0099
ADSRAZ	5.0 MERU/G	0.0000	0.0000	0.0011	- 0.0010	- 0.0000	0.0004
ADOAZ	1.0 MERU/G	0.0000	0.0000	- 0.0234	0.0216	0.0000	- 0.0092
ADIXX	0.2 MERU/GSQ	0.0047	0.0000	0.0000	0.0018	- 0.0000	0.0043
ADSYY	0.2 MERU/GSQ	0.0000	0.0001	0.0000	- 0.0000	0.0001	0.0000
ADIZZ	0.2 MERU/GSQ	0.0000	0.0000	- 0.0001	0.0001	0.0000	- 0.0000
RSS DRIFT ANGLE		0.1946	0.0575	0.0607	0.0947	0.0575	0.1805
OVERALL RSS MLM		0.3044	0.2411	0.2419	0.2525	0.2411	0.2956

TABLE 7.12 S.M. MISALIGNMENTS AND DRIFT ANGLES AT TLI CUTOFF

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POSITION AND VELOCITY UNCERTAINTIES ALONG LOCAL AXES AT TIME = 0 HR. 6 MIN. 22.352 SECS (382.352 SECS)

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	POSITION UNCERTAINTIES IN FEET (REL.TO ACT.AXES AT NOM.TIME) ALT.	TRACK	RANGE	VELOCITY UNCERTAINTIES IN FT/SEC (REL.TO ACT.AXES AT NOM.TIME) ALT.	TRACK	RANGE
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED WITH GYRO DRIFT ANGLES) ABOUT STABLE MEMBER AXES							
ABOUT XSM	40.0 SECS	7.5	6.0	1.8	0.058	0.058	0.019
ABOUT YSM	40.0 SECS	-109.3	25.2	14.2	-0.602	0.151	0.051
ABOUT ZSM	40.0 SECS	27.9	100.8	34.7	0.184	0.553	0.183
ACCELEROMETER INPUT AXIS MISALIGNMENTS							
X ABOUT Y	28.3 SECS	-0.6	2.2	-5.1	-0.010	0.020	-0.047
X ABOUT Z	20.0 SECS	0.3	-1.1	2.6	0.004	-0.008	0.017
Y ABOUT X	20.0 SECS	1.0	3.6	1.4	0.011	0.033	0.013
Y ABOUT Z	20.0 SECS	-14.4	-49.7	-20.1	-0.096	-0.270	-0.109
Z ABOUT X	20.0 SECS	2.7	-0.6	-0.5	0.018	-0.004	-0.004
Z ABOUT Y	0.0 SECS	0.0	0.0	0.0	0.000	0.000	0.000
ACCELEROMETER BIAS							
ACBX	0.200 CM/S.SQ	-48.3	189.1	-434.2	-0.630	0.981	-2.249
ACBY	0.200 CM/S.SQ	-123.4	-426.4	-172.1	-0.796	-2.208	-0.891
ACBZ	0.200 CM/S.SQ	469.8	-95.6	-93.2	2.421	-0.503	-0.484
ACCELEROMETER SCALE FACTOR UNCERTAINTIES							
SFUX	116.0 PPM	-6.7	26.4	-60.5	-0.090	0.143	-0.329
SFUY	116.0 PPM	-0.9	-3.0	-1.2	-0.007	-0.020	-0.008
SFUZ	116.0 PPM	4.6	-0.9	-0.9	0.042	-0.009	-0.008
GYRO BIAS DRIFT (15 MIN.DRIFT TIME BEFORE TRAJ.START RESULTING IN 0.131 MR. INITIAL MLM. ABOUT EACH S.M. AXIS)							
NBDXINIT	2.0 MERU	5.1	4.1	1.2	0.039	0.039	0.013
NBDXFLGT	(0.056 MR.DRIFT	1.0	1.0	0.3	0.011	0.012	0.004
NBDXCOMB	SINCE TRAJ.START)	6.2	5.1	1.5	0.050	0.051	0.017
NBDYINIT	2.0 MERU	-74.0	17.1	9.6	-0.408	0.102	0.035
NBDYFLGT	(0.056 MR.DRIFT	-11.0	2.7	1.0	-0.091	0.024	0.004
NBDYCOMB	SINCE TRAJ.START)	-85.0	19.8	10.7	-0.499	0.127	0.039
NBDZINIT	2.0 MERU	18.9	68.2	23.5	0.124	0.375	0.124
NBDZFLGT	(0.056 MR.DRIFT	2.8	10.3	3.4	0.026	0.085	0.027
NBDZCOMB	SINCE TRAJ.START)	21.7	78.5	26.8	0.150	0.459	0.151
GYRO ACCELERATION SENSITIVE DRIFT							
ADX-TERMS	8.0, 5.0 MERU/G	1.0	1.0	0.3	0.011	0.012	0.004
ADY-TERMS	8.0, 5.0 MERU/G	1.4	0.4	0.1	0.013	0.003	0.000
ADZ-TERMS	8.0, 5.0 MERU/G	0.4	1.4	0.4	0.004	0.012	0.004
GYRO ACCELERATION SQUARED SENSITIVE DRIFT							
ADIXX	0.2 MERU/GSQ	0.0	0.0	0.0	0.000	0.000	0.000
ADSYY	0.2 MERU/GSQ	0.0	0.0	0.0	0.000	0.000	0.000
ADIZZ	0.2 MERU/GSQ	0.0	0.0	0.0	0.000	0.000	0.000
RSS UNCERT.(FT AND FT/SEC)		509.0	497.3	482.9	2.754	2.598	2.505
RSS TKG.UPDATE UNCERT.		1078.2	7266.3	4645.3	0.273	11.028	0.369
OVERALL RSS UNCERTAINTIES		1192.3	7283.3	4670.4	2.768	11.330	2.532

TABLE 7.13 POSITION AND VELOCITY UNCERTAINTIES AT LOI CUTOFF

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UNCERTAINTIES IN (AT TIME = 0 HR. 6 MIN. 22.352 SEC (382.352 SECS))

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	INERTIAL FLIGHT PATH ANGLE (DEG)	INERTIAL VELOCITY (FT/SEC)	INERTIAL AZIMUTH (DEG)	ORBIT INCLIN. (DEG)	LATITUDE (DEG)	LONGITUDE (DEG)	ALT.AT PERIGEE (FEET)
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED)								
ABOUT XSM	40.0 SECS	0.0006	0.0189	0.0006	0.0006	0.0000	0.0000	7.54
ABOUT YSM	40.0 SECS	-0.0065	0.0514	0.0016	0.0017	0.0002	-0.0002	-109.31
ABOUT ZSM	40.0 SECS	0.0020	0.1828	0.0060	0.0061	0.0007	-0.0007	27.95
ACCELEROMETER INPUT AXIS MISALIGNMENTS								
X ABOUT Y	28.3 SECS	-0.0001	-0.0469	0.0002	0.0002	0.0000	0.0000	-0.57
X ABOUT Z	20.0 SECS	0.0000	0.0173	-0.0001	-0.0001	0.0000	0.0000	0.28
Y ABOUT X	20.0 SECS	0.0001	0.0132	0.0004	0.0004	0.0000	0.0000	1.03
Y ABOUT Z	20.0 SECS	-0.0010	-0.1090	-0.0029	-0.0030	-0.0003	0.0004	-14.37
Z ABOUT X	20.0 SECS	0.0002	-0.0037	0.0000	0.0000	0.0000	0.0000	2.74
Z ABOUT Y	0.0 SECS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
ACCELEROMETER BIAS								
ACBXINIT		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
ACBXFLGT	0.200 CM/S.SQ	-0.0068	-2.2494	0.0106	0.0108	0.0033	0.0029	-48.26
ACBXCOMB		-0.0068	-2.2494	0.0106	0.0108	0.0033	0.0029	-48.26
ACBYINIT		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
ACBYFLGT	0.200 CM/S.SQ	-0.0086	-0.8909	-0.0239	-0.0242	-0.0029	0.0031	-123.40
ACBYCOMB		-0.0086	-0.8909	-0.0239	-0.0242	-0.0029	0.0031	-123.40
ACBZINIT		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
ACBZFLGT	0.200 CM/S.SQ	0.0262	-0.4833	-0.0054	-0.0055	-0.0005	0.0012	469.85
ACBZCOMB		0.0262	-0.4833	-0.0054	-0.0055	-0.0005	0.0012	469.85
ACCELEROMETER SCALE FACTOR UNCERTAINTIES								
SFUX	116.0 PPM	-0.0010	-0.3292	0.0016	0.0016	0.0005	0.0004	-6.73
SFUY	116.0 PPM	-0.0001	-0.0082	-0.0002	-0.0002	0.0000	0.0000	-0.87
SFUZ	116.0 PPM	0.0005	-0.0084	-0.0001	-0.0001	0.0000	0.0000	4.64
GYRO BIAS DRIFT								
NBDXINIT		0.0004	0.0128	0.0004	0.0004	0.0000	0.0000	5.10
NBDXFLGT	2.0 MERU	0.0001	0.0041	0.0001	0.0001	0.0000	0.0000	1.05
NBDXCOMB		0.0005	0.0169	0.0006	0.0006	0.0000	0.0000	6.15
NBDYINIT		-0.0044	0.0348	0.0011	0.0011	0.0001	-0.0001	-73.99
NBDYFLGT	2.0 MERU	-0.0010	0.0041	0.0003	0.0003	0.0000	0.0000	-11.04
NBDYCOMB		-0.0054	0.0389	0.0014	0.0014	0.0001	-0.0002	-85.03
NBDZINIT		0.0013	0.1237	0.0041	0.0041	0.0005	-0.0005	18.92
NBDZFLGT	2.0 MERU	0.0003	0.0270	0.0009	0.0009	0.0001	-0.0001	2.81
NBDZCOMB		0.0016	0.1507	0.0050	0.0050	0.0006	-0.0005	21.73
GYRO ACCELERATION SENSITIVE DRIFT (RSS OF UNCERTAINTIES DUE TO ADIA, ADSRA AND ADUA UNCERTAINTIES FOR EACH GYRO)								
ADX-TERMS 8.0, 5.0 MERU/G		0.0001	0.0041	0.0001	0.0001	0.0000	0.0000	1.02
ADY-TERMS 8.0, 5.0 MERU/G		0.0001	0.0005	0.0000	0.0000	0.0000	0.0000	1.43
ADZ-TERMS 8.0, 5.0 MERU/G		0.0000	0.0038	0.0001	0.0001	0.0000	0.0000	0.37
RSS UNCERTAINTIES		0.0298	2.5042	0.0281	0.0285	0.0045	0.0045	509.05

TABLE 7.14 OTHER UNCERTAINTIES AT LOI CUTOFF

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INITIAL S.M.MLMS. AND DRIFT ANGLES SUMMARY (S.M.ANGLES AXI=-160.258, AYPI=- 77.177, AZSM=-180.000 DEG)(T= 382.352 SEC)

UNCERT. SOURCE	ONE SIGMA UNCERT.	VALUE	MLM. ANGLE ABOUT STABLE MEMBER AXES XSM	MR. YSM	ZSM	MLM. ANGLE ABOUT LOCAL VERTICAL AXES ALT.	MR. TRACK	RANGE
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED WITH GYRO DRIFT ANGLES) ABOUT								
ABOUT XSM	40	SECS	0.1939	0.0000	0.0000	0.0195	- 0.0770	0.1769
ABOUT YSM	40	SECS	0.0000	0.1939	0.0000	0.0497	0.1737	0.0701
ABOUT ZSM	40	SECS	0.0000	0.0000	0.1939	- 0.1864	0.0383	0.0372
INITIAL S.M. MLMS. AT TRAJ. START DUE TO GYRO BIAS DRIFT FOR 15 MINS. PRIOR TO START OF TRAJECTORY								
NBDX	2.0	MERU	0.1312	0.0000	0.0000	0.0132	- 0.0521	0.1197
NBDY	2.0	MERU	0.0000	0.1312	0.0000	0.0336	0.1176	0.0474
NBDZ	2.0	MERU	0.0000	0.0000	0.1312	- 0.1261	0.0259	0.0252
RSS INITIAL S.M. MLMS.			0.2341	0.2341	0.2341	0.2341	0.2341	0.2341
DRIFT ANGLES DUE TO GYRO DRIFT AFTER TRAJECTORY START								
NBDX	2.0	MERU	0.0557	0.0000	0.0000	0.0056	- 0.0221	0.0508
NBDY	2.0	MERU	0.0000	0.0557	0.0000	0.0143	0.0500	0.0201
NBDZ	2.0	MERU	0.0000	0.0000	- 0.0557	0.0536	- 0.0110	- 0.0107
ADIAX	8.0	MERU/G	- 0.0573	0.0000	0.0000	- 0.0057	0.0227	- 0.0523
ADSRAX	5.0	MERU/G	0.0022	0.0000	0.0000	0.0002	- 0.0008	0.0020
ADOAX	1.0	MERU/G	- 0.0008	0.0000	0.0000	- 0.0000	0.0003	- 0.0007
ADIAY	8.0	MERU/G	0.0000	- 0.0035	0.0000	- 0.0009	- 0.0032	- 0.0012
ADSRAY	5.0	MERU/G	0.0000	0.0042	0.0000	0.0010	0.0038	0.0015
ADOAY	1.0	MERU/G	0.0000	- 0.0071	0.0000	- 0.0018	- 0.0064	- 0.0025
ADIAZ	8.0	MERU/G	0.0000	0.0000	- 0.0068	0.0065	- 0.0013	- 0.0013
ADSRAZ	5.0	MERU/G	0.0000	0.0000	- 0.0022	0.0021	- 0.0004	- 0.0004
ADOAZ	1.0	MERU/G	0.0000	0.0000	0.0071	- 0.0068	0.0014	0.0013
ADIXX	0.2	MERU/GSQ	0.0003	0.0000	0.0000	0.0000	- 0.0001	0.0003
ADSYY	0.2	MERU/GSQ	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ADIZZ	0.2	MERU/GSQ	0.0000	0.0000	- 0.0000	0.0000	- 0.0000	- 0.0000
RSS DRIFT ANGLE			0.0800	0.0565	0.0567	0.0569	0.0608	0.0766
OVERALL RSS MLM			0.2474	0.2408	0.2409	0.2410	0.2419	0.2463

TABLE 7.15 S.M. MISALIGNMENTS AND DRIFT ANGLES AT LOI CUTOFF

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INITIAL CONDITION AND GUID.ERROR COVARIANCE MATRICES
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PROPAGATED INIT.COND.COVAR.MATRIX (A,T,R COORDS.-FT AND FT/SEC)

 34   1.149530157  06   -5.946231387  06   -4.077162804  06    3.882149058  03    8.912604219  03   -3.258647795  02
 35  -5.946231480  06    5.281816096  07    2.844022008  07   -2.894111878  04   -8.014094759  04    1.243455831  03
 36  -4.077162827  06    2.844022008  07    2.158747182  07   -1.932628092  04   -4.298952995  04    6.848526140  02
 37   3.882149081  03   -2.894111889  04   -1.932628092  04    1.811997661  01    4.379033102  01   -7.439605760 -01
 38   8.912604410  03   -8.014094799  04   -4.298952995  04    4.379033120  01    1.216255127  02   -1.841381077  00
 39  -3.258647659  02    1.243455836  03    6.848526239  02   -7.439605520 -01   -1.841380999  00    1.373139090 -01

SQ.RTS.FOR    (FEET+FT/SEC)      1072.1    -    7267.6    -    4646.2              4.256        11.028    -    0.370
MATRIX NO. 1  (N.M.+FT/SEC)      0.1764    -    1.1960    -    0.7646              4.256        11.028    -    0.370
              (N.M.+FT/SEC)                   1.4305                                           11.827
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GUIDANCE ERROR COVAR.MATRIX (A,T,R COORDS.-FT AND FT/SEC)

 40   2.591271639  05   -7.156115916  02   -1.775142127  03    1.387515610  03   -9.297840271  00   -5.328459691  00
 41  -7.156115916  02    2.473274805  05    5.781305959  03   -7.646094531  00    1.291329212  03    3.028810863  01
 42  -1.775142127  03    5.781305959  03    2.331804199  05   -1.036117099  01    3.297832091  01    1.209248318  03
 43   1.387515610  03   -7.646094531  00   -1.036117099  01    7.434600688  00   -6.972897342 -02   -3.093398852 -02
 44  -9.297840271  00    1.291329212  03    3.297832091  01   -6.972897342 -02    6.748468073  00    1.728385872 -01
 45  -5.328459691  00    3.028810863  01    1.209248318  03   -3.093398852 -02    1.728385872 -01    6.272870808  00

SQ.RTS.FOR    (FEET+FT/SEC)       509.0    -     497.3    -     482.8              2.726    -    2.597    -    2.504
MATRIX NO. 2  (N.M.+FT/SEC)      0.0837    -    0.0818    -    0.0794              2.726    -    2.597    -    2.504
              (N.M.+FT/SEC)                   0.1415                                           4.522
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

INIT.COND.+GUID.ERROR COVAR.MATR.(A,T,R COORDS.-FT AND FT/SEC)

 46   1.408657320  06   -5.946946998  06   -4.078937945  06    5.269664668  03    8.903306379  03   -3.311932391  02
 47  -5.946947091  06    5.306548844  07    2.844600138  07   -2.894876487  04   -7.884961838  04    1.273743939  03
 48  -4.078937969  06    2.844600138  07    2.182065223  07   -1.933664209  04   -4.295655163  04    1.894100932  03
 49   5.269664691  03   -2.894876498  04   -1.933664209  04    2.555457729  01    4.372060205  01   -7.748945645 -01
 50   8.903306570  03   -7.884961878  04   -4.295655163  04    4.372060223  01    1.283739807  02   -1.668542490  00
 51  -3.311932255  02    1.273743944  03    1.894100941  03   -7.748945405 -01   -1.668542412  00    6.410184717  00

SQ.RTS.FOR    (FEET+FT/SEC)      1186.8    -    7284.6    -    4671.2              5.055        11.330    -    2.531
MATRIX NO. 3  (N.M.+FT/SEC)      0.1953    -    1.1988    -    0.7687              5.055        11.330    -    2.531
              (N.M.+FT/SEC)                   1.4375                                           12.662
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TABLE 7.16 UNCERTAINTY COVARIANCE MATRICES AT LOI CUTOFF

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POSITION AND VELOCITY UNCERTAINTIES ALONG LOCAL AXES AT TIME = 1 HR. 4 MIN. 25.584 SECS (3865.584 SECS)

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	POSITION UNCERTAINTIES IN FEET (REL.TO ACT.AXES AT NOM.TIME) ALT.	TRACK	RANGE	VELOCITY UNCERTAINTIES IN FT/SEC (REL.TO ACT.AXES AT NOM.TIME) ALT.	TRACK	RANGE
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED WITH GYRO DRIFT ANGLES) ABOUT STABLE MEMBER AXES							
ABOUT XSM	40.0 SECS	122.9	5.7	-515.7	-0.049	-0.057	-0.079
ABOUT YSM	40.0 SECS	-209.9	5.6	3259.9	0.590	-0.152	0.137
ABOUT ZSM	40.0 SECS	974.5	12.2	-2820.7	-0.108	-0.558	-0.620
ACCELEROMETER INPUT AXIS MISALIGNMENTS							
X ABOUT Y	28.3 SECS	-222.5	1.9	497.0	-0.008	-0.020	0.142
X ABOUT Z	20.0 SECS	82.4	-0.4	-185.9	0.002	0.008	-0.052
Y ABOUT X	20.0 SECS	66.6	3.1	-183.8	-0.006	-0.033	-0.043
Y ABOUT Z	20.0 SECS	-571.4	-5.5	1603.2	0.053	0.272	0.364
Z ABOUT X	20.0 SECS	-5.2	-0.2	-74.1	-0.019	0.004	0.003
Z ABOUT Y	0.0 SECS	0.0	0.0	0.0	0.000	0.000	0.000
ACCELEROMETER BIAS							
ACBX	0.200 CM/S.SQ	-10721.0	11.4	24637.8	-0.140	-0.990	6.901
ACBY	0.200 CM/S.SQ	-4677.8	-25.0	13194.2	0.451	2.230	2.999
ACBZ	0.200 CM/S.SQ	-346.5	-7.2	-10725.6	-2.465	0.508	0.227
ACCELEROMETER SCALE FACTOR UNCERTAINTIES							
SFUX	116.0 PPM	-1573.5	3.0	3588.0	-0.031	-0.145	1.004
SFUY	116.0 PPM	-42.3	-1.1	117.6	0.004	0.020	0.027
SFUZ	116.0 PPM	-16.8	-0.8	-154.7	-0.043	0.009	0.010
GYRO BIAS DRIFT (15 MIN.DRIFT TIME BEFORE TRAJ.START RESULTING IN 0.131 MR. INITIAL MLM. ABOUT EACH S.M. AXIS)							
NBDXINIT	2.0 MERU	83.1	3.8	-349.1	-0.033	-0.039	-0.053
NBDXFLGT	(0.564 MR.DRIFT	24.6	1.5	-98.4	-0.009	-0.012	-0.016
NBDXCOMB	SINCE TRAJ.START)	107.7	5.3	-447.5	-0.042	-0.051	-0.069
NBDYINIT	2.0 MERU	-142.3	3.8	2206.4	0.399	-0.103	0.092
NBDYFLGT	(0.564 MR.DRIFT	-32.7	2.2	479.7	0.089	-0.024	0.022
NBDYCOMB	SINCE TRAJ.START)	-174.8	6.0	2686.1	0.488	-0.127	0.115
NBDZINIT	2.0 MERU	659.5	8.3	-1909.3	-0.073	-0.378	-0.420
NBDZFLGT	(0.564 MR.DRIFT	139.6	6.9	-401.7	-0.015	-0.085	-0.089
NBDZCOMB	SINCE TRAJ.START)	799.2	15.2	-2310.9	-0.089	-0.462	-0.509
GYRO ACCELERATION SENSITIVE DRIFT							
ADX-TERMS	8.0, 5.0 MERU/G	24.4	1.5	97.6	0.009	0.012	0.016
ADY-TERMS	8.0, 5.0 MERU/G	4.6	0.3	67.0	0.012	0.003	0.003
ADZ-TERMS	8.0, 5.0 MERU/G	20.2	1.2	58.0	0.002	0.012	0.013
GYRO ACCELERATION SQUARED SENSITIVE DRIFT							
ADIXX	0.2 MERU/GSQ	0.1	0.0	-0.6	0.000	0.000	0.000
ADSYY	0.2 MERU/GSQ	0.0	0.0	0.0	0.000	0.000	0.000
ADIZZ	0.2 MERU/GSQ	0.0	0.0	0.0	0.000	0.000	0.000
RSS UNCERT.(FT AND FT/SEC)		11895.3	37.1	30717.7	2.629	2.623	7.650
RSS TKG.UPDATE UNCERT.		2121.3	9413.0	12880.3	0.413	9.757	1.139
OVERALL RSS UNCERTAINTIES		12083.0	9413.2	33308.9	2.661	10.104	7.734

TABLE 7.17 UNCERTAINTIES AT MAX. ALTITUDE UNCERTAINTY POINT IN ORBIT AFTER LOI CUTOFF

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POSITION AND VELOCITY UNCERTAINTIES ALONG LOCAL AXES AT TIME = 0 HR, 1 MIN, 59.603 SECS (119.603 SECS)

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	POSITION UNCERTAINTIES IN FEET (REL.TO ACT.AXES AT NOM.TIME) ALT.	TRACK	RANGE	VELOCITY UNCERTAINTIES IN FT/SEC (REL.TO ACT.AXES AT NOM.TIME) ALT.	TRACK	RANGE
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED WITH GYRO DRIFT ANGLES) ABOUT STABLE MEMBER AXES							
ABOUT XSM	40.0 SECS	0.1	-1.6	0.0	0.003	-0.043	0.000
ABOUT YSM	40.0 SECS	29.0	-0.3	-2.6	0.508	-0.006	-0.029
ABOUT ZSM	40.0 SECS	-0.3	-29.0	0.2	-0.006	-0.507	0.003
ACCELEROMETER INPUT AXIS MISALIGNMENTS							
X ABOUT Y	28.3 SECS	0.2	0.0	1.1	0.006	0.000	0.030
X ABOUT Z	20.0 SECS	0.0	0.0	0.1	0.000	0.000	0.002
Y ABOUT X	20.0 SECS	0.0	-0.8	0.0	0.000	-0.022	0.000
Y ABOUT Z	20.0 SECS	0.2	14.7	-0.2	0.003	0.255	-0.003
Z ABOUT X	20.0 SECS	0.1	0.0	0.0	0.002	0.000	0.000
Z ABOUT Y	0.0 SECS	0.0	0.0	0.0	0.000	0.000	0.000
ACCELEROMETER BIAS							
ACBX	0.200 CM/S.SQ	-6.7	-0.5	-46.4	-0.172	-0.009	-0.773
ACBY	0.200 CM/S.SQ	-0.5	-46.9	0.6	-0.008	-0.781	0.010
ACBZ	0.200 CM/S.SQ	46.5	-0.6	-6.7	0.771	-0.010	-0.112
ACCELEROMETER SCALE FACTOR UNCERTAINTIES							
SFUX	116.0 PPM	2.5	0.2	17.4	0.066	0.003	0.302
SFUY	116.0 PPM	0.0	-0.1	0.0	0.000	-0.002	0.000
SFUZ	116.0 PPM	-0.9	0.0	0.1	-0.026	0.000	0.004
GYRO BIAS DRIFT (15 MIN.DRIFT TIME BEFORE TRAJ.START RESULTING IN 0.131 MR. INITIAL MLM. ABOUT EACH S.M. AXIS)							
NBDXINIT	2.0 MERU	0.1	-1.1	0.0	0.002	-0.029	0.000
NBDXFLGT	(0.01/ MR.DRIFT	0.0	-0.1	0.0	0.000	-0.003	0.000
NBDXCOMB	SINCE TRAJ.START)	0.1	-1.1	0.0	0.003	-0.032	0.000
NBDYINIT	2.0 MERU	19.6	-0.2	-1.7	0.344	-0.004	-0.020
NBDYFLGT	(0.01/ MR.DRIFT	0.9	0.0	-0.1	0.024	0.000	-0.001
NBDYCOMB	SINCE TRAJ.START)	20.5	-0.2	-1.8	0.368	-0.004	-0.021
NBDZINIT	2.0 MERU	-0.2	-19.6	0.2	-0.004	-0.343	0.002
NBDZFLGT	(0.01/ MR.DRIFT	0.0	-0.9	0.0	0.000	-0.024	0.000
NBDZCOMB	SINCE TRAJ.START)-	0.2	-20.5	0.2	-0.004	-0.367	0.002
GYRO ACCELERATION SENSITIVE DRIFT							
ADX-TERMS	8.0, 5.0 MERU/G	0.0	0.2	0.0	0.001	0.007	0.000
ADY-TERMS	8.0, 5.0 MERU/G	0.3	0.0	0.0	0.008	0.000	0.000
ADZ-TERMS	8.0, 5.0 MERU/G	0.0	0.3	0.0	0.000	0.009	0.000
GYRO ACCELERATION SQUARED SENSITIVE DRIFT							
ADIXX	0.2 MERU/GSQ	0.0	0.0	0.0	0.000	0.000	0.000
ADSYY	0.2 MERU/GSQ	0.0	0.0	0.0	0.000	0.000	0.000
ADIZZ	0.2 MERU/GSQ	0.0	0.0	0.0	0.000	0.000	0.000
RSS UNCERT.(FT AND FT/SEC)		59.0	60.7	50.1	1.011	1.034	0.839
RSS TKG.UPDATE UNCERT.		530.3	532.5	2834.4	1.800	0.800	0.574
OVERALL RSS UNCERTAINTIES		533.6	536.0	2834.9	2.065	1.307	1.017

TABLE 7.18 POSITION AND VELOCITY UNCERTAINTIES AT TEI CUTOFF

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****
UNCERTAINTIES IN (AT TIME = 0 HR, 1 MIN, 59.603 SEC (119.603 SECS))
****

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	INERTIAL FLIGHT PATH ANGLE (DEG)	INERTIAL VELOCITY (FT/SEC)	INERTIAL AZIMUTH (DEG)	FREE FALL TIME TO NOM. ALT. (SECS)	LATITUDE (DEG)	LONGITUDE (DEG)	RANGE (N.MILE)
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED)								
ABOUT XSM	40.0 SECS	0.0000	0.0001	-0.0003	-0.0004	0.0000	0.0000	0.00
ABOUT YSM	40.0 SECS	0.0037	-0.0093	0.0000	-0.0921	0.0000	0.0000	0.00
ABOUT ZSM	40.0 SECS	0.0000	0.0025	-0.0037	0.0011	-0.0003	0.0000	0.00
ACCELEROMETER INPUT AXIS MISALIGNMENTS								
X ABOUT Y	28.3 SECS	0.0000	0.0305	0.0000	-0.0005	0.0000	0.0000	0.00
X ABOUT Z	20.0 SECS	0.0000	0.0020	0.0000	0.0000	0.0000	0.0000	0.00
Y ABOUT X	20.0 SECS	0.0000	0.0003	-0.0002	0.0000	0.0000	0.0000	0.00
Y ABOUT Z	20.0 SECS	0.0000	-0.0032	0.0018	-0.0005	0.0001	0.0000	0.00
Z ABOUT X	20.0 SECS	0.0000	-0.0002	0.0000	-0.0002	0.0000	0.0000	0.00
Z ABOUT Y	0.0 SECS	0.0000	0.0000	0.0000	-0.0005	0.0000	0.0000	0.00
ACCELEROMETER BIAS								
ACBXINIT		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
ACBXFLGT	0.200 CM/S.SQ	-0.0010	-0.7792	-0.0001	0.0214	0.0001	0.0004	-0.01
ACBXCOMB		-0.0010	-0.7792	-0.0001	0.0214	0.0001	0.0004	-0.01
ACBYINIT		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
ACBYFLGT	0.200 CM/S.SQ	-0.0001	0.0099	-0.0056	0.0016	-0.0004	0.0001	0.00
ACBYCOMB		-0.0001	0.0099	-0.0056	0.0016	-0.0004	0.0001	0.00
ACBZINIT		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
ACBZFLGT	0.200 CM/S.SQ	0.0056	-0.0809	-0.0001	-0.1478	0.0000	0.0001	0.00
ACBZCOMB		0.0056	-0.0809	-0.0001	-0.1478	0.0000	0.0001	0.00
ACCELEROMETER SCALE FACTOR UNCERTAINTIES								
SFUX	116.0 PPM	0.0004	0.3042	0.0000	-0.0080	0.0000	-0.0002	0.00
SFUY	116.0 PPM	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
SFUZ	116.0 PPM	-0.0002	0.0027	0.0000	0.0030	0.0000	0.0000	0.00
GYRO BIAS DRIFT								
NBDXINIT		0.0000	0.0001	-0.0002	-0.0003	0.0000	0.0000	0.00
NBDXFLGT	2.0 MERU	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.00
NBDXCOMB		0.0000	0.0001	-0.0002	-0.0003	0.0000	0.0000	0.00
NBDYINIT		0.0025	-0.0063	0.0000	-0.0624	0.0000	0.0000	0.00
NBDYFLGT	2.0 MERU	0.0002	0.0002	0.0000	-0.0029	0.0000	0.0000	0.00
NBDYCOMB		0.0027	-0.0061	0.0000	-0.0653	0.0000	0.0000	0.00
NBDZINIT		0.0000	0.0017	-0.0025	0.0007	-0.0002	0.0000	0.00
NBDZFLGT	2.0 MERU	0.0000	0.0001	-0.0002	0.0000	0.0000	0.0000	0.00
NBDZCOMB		0.0000	0.0017	-0.0027	0.0008	-0.0002	0.0000	0.00
GYRO ACCELERATION SENSITIVE DRIFT (RSS OF UNCERTAINTIES DUE TO ADIA, ADSRA AND ADOA UNCERTAINTIES FOR EACH GYRO)								
ADX-TERMS 8.0, 5.0 MERU/G		0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.00
ADY-TERMS 8.0, 5.0 MERU/G		0.0001	0.0001	0.0000	0.0009	0.0000	0.0000	0.00
ADZ-TERMS 8.0, 5.0 MERU/G		0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.00
RSS UNCERTAINTIES		0.0073	0.8413	0.0075	0.1874	0.0006	0.0005	0.01

TABLE 7.19 OTHER UNCERTAINTIES AT TEI CUTOFF

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INITIAL S.M.MLMS. AND DRIFT ANGLES SUMMARY (S.M.ANGLES AXI= 3.422, AYPI=- 89.026, AZSM= 0.000 DEG)(T= 119.602 SEC)

UNCERT. SOURCE	ONE SIGMA UNCERT.VALUE		MLM. ANGLE ABOUT STABLE MEMBER AXES XSM	MR. YSM	ZSM	MLM.ANGLE ABOUT LOCAL VERTICAL AXES ALT.	MR. TRACK	RANGE
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED WITH GYRO DRIFT ANGLES) ABOUT								
ABOUT XSM	40	SECS	0.1939	0.0000	0.0000	0.0276	0.0021	0.1919
ABOUT YSM	40	SECS	0.0000	0.1939	0.0000	0.0021	0.1938	- 0.0025
ABOUT ZSM	40	SECS	0.0000	0.0000	0.1939	- 0.1919	0.0024	0.0276
INITIAL S.M. MLMS. AT TRAJ. START DUE TO GYRO BIAS DRIFT FOR 15 MINS. PRIOR TO START OF TRAJECTORY								
NBDX	2.0	MERU	0.1312	0.0000	0.0000	0.0187	0.0014	0.1299
NBDY	2.0	MERU	0.0000	0.1312	0.0000	0.0014	0.1312	- 0.0017
NBDZ	2.0	MERU	0.0000	0.0000	0.1312	- 0.1299	0.0016	0.0187
RSS INITIAL S.M. MLMS.			0.2341	0.2341	0.2341	0.2341	0.2341	0.2341
DRIFT ANGLES DUE TO GYRO DRIFT AFTER TRAJECTORY START								
NBDX	2.0	MERU	0.0174	0.0000	0.0000	0.0024	0.0001	0.0172
NBDY	2.0	MERU	0.0000	0.0174	0.0000	0.0001	0.0174	- 0.0002
NBDZ	2.0	MERU	0.0000	0.0000	- 0.0174	0.0172	- 0.0002	- 0.0024
ADIAX	8.0	MERU/G	0.0478	0.0000	0.0000	0.0068	0.0005	0.0473
ADSRAX	5.0	MERU/G	0.0002	0.0000	0.0000	0.0000	0.0000	0.0002
ADOAX	1.0	MERU/G	0.0005	0.0000	0.0000	0.0000	0.0000	0.0005
ADIAY	8.0	MERU/G	0.0000	- 0.0003	0.0000	- 0.0000	- 0.0003	0.0000
ADSRAY	5.0	MERU/G	0.0000	- 0.0025	0.0000	- 0.0000	- 0.0025	0.0000
ADOAY	1.0	MERU/G	0.0000	0.0059	0.0000	0.0000	0.0059	- 0.0000
ADIAZ	8.0	MERU/G	0.0000	0.0000	0.0040	- 0.0040	0.0000	0.0005
ADSRAZ	5.0	MERU/G	0.0000	0.0000	- 0.0002	0.0002	- 0.0000	- 0.0000
ADOAZ	1.0	MERU/G	0.0000	0.0000	- 0.0059	0.0059	- 0.0000	- 0.0008
ADIXX	0.2	MERU/GSQ	0.0008	0.0000	0.0000	0.0001	0.0000	0.0008
ADSYY	0.2	MERU/GSQ	0.0000	0.0000	0.0000	0.0000	0.0000	- 0.0000
ADIZZ	0.2	MERU/GSQ	0.0000	0.0000	- 0.0000	0.0000	- 0.0000	- 0.0000
RSS DRIFT ANGLE			0.0509	0.0186	0.0188	0.0200	0.0186	0.0505
OVERALL RSS MLM			0.2396	0.2349	0.2349	0.2350	0.2349	0.2395

TABLE 7.20 S.M. MISALIGNMENTS AND DRIFT ANGLES AT TEI CUTOFF

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*************************************************
INITIAL CONDITION AND GUID.ERROR COVARIANCE MATRICES
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PROPAGATED INIT.COND.COVAR.MATRIX (A.T.R COORDS.-FT AND FT/SEC)

 130   2.806253885  05    1.630920774  04    2.368072658  05   -1.303278798  02   -1.564159047  01   -2.217096322  02
 131   1.630920774  04    2.836174761  05    5.659250216  05   -3.747314564  02   -1.021681855  02    1.285971817  01
 132   2.368072660  05    5.659250217  05    8.035600839  06   -5.152236067  03    9.610579370  00    5.493319490  01
 133  -1.303278797  02   -3.747314563  02   -5.152236066  03    3.332701357  00   -2.987052330 -03   -5.112094470 -02
 134  -1.564159045  01   -1.021681857  02    9.610579418  00   -2.987052280 -03    5.969183313 -01   -3.070315276 -02
 135  -2.217096320  02    1.285971818  01    5.493319504  01   -5.112094415 -02   -3.070315275 -02    1.856007443 -01

SQ.RTS.FOR     (FEET+FT/SEC)      529.7          532.5          2834.7          -    1.825    -    0.772    -    0.430
MATRIX NO. 1   (N.M.+FT/SEC)     0.0871         0.0876          0.4665          -    1.825    -    0.772    -    0.430
               (N.M.+FT/SEC)                    0.4826                                                2.028
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

GUIDANCE ERROR COVAR.MATRIX (A.T.R COORDS.-FT AND FT/SEC)

 136   3.478333368  03    1.904121585  00   -6.885470672  01    5.959105960  01    3.707811845 -02   -5.351787549 -01
 137   1.904121585  00    3.679261616  03   -8.287189952  00    3.709689301 -02    6.289013464  01   -9.090987139 -02
 138  -6.885470672  01   -8.287189952  00    2.512951313  03   -1.239456359  00   -1.472120341 -01    4.216390985  01
 139   5.959105960  01    3.709689301 -02   -1.239456359  00    1.021939908  00    6.854188542 -04   -9.767438916 -03
 140   3.707811845 -02    6.289013464  01   -1.472120341 -01    6.854188522 -04    1.076333591  00   -1.615116732 -03
 141  -5.351787549 -01   -9.090987139 -02    4.216390985  01   -9.767438916 -03   -1.615116732 -03    7.080172899 -01

SQ.RTS.FOR     (FEET+FT/SEC)       58.9           60.6     -      50.1                1.010          1.037    -    0.841
MATRIX NO. 2   (N.M.+FT/SEC)     0.0097         0.0099     -    0.0082                1.010          1.037    -    0.841
               (N.M.+FT/SEC)                    0.0161                                                1.675
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

INIT.COND.+GUID.ERROR COVAR.MATR.(A.T.R COORDS.-FT AND FT/SEC)

 142   2.841037218  05    1.631111186  04    2.367384111  05   -7.073682020  01   -1.560451236  01   -2.222448109  02
 143   1.631111186  04    2.872967377  05    5.659167345  05   -3.746943596  02   -3.927805090  01    1.276880830  01
 144   2.367384113  05    5.659167346  05    8.038113790  06   -5.153475523  03    9.463367336  00    9.709710475  01
 145  -7.073682010  01   -3.746943595  02   -5.153475522  03    4.354641265  00   -2.301633478 -03   -6.088838361 -02
 146  -1.560451234  01   -3.927805110  01    9.463367384  00   -2.301633428 -03    1.673251922  00   -3.231826949 -02
 147  -2.222448107  02    1.276880831  01    9.709710489  01   -6.088838306 -02   -3.231826948 -02    8.936180342 -01

SQ.RTS.FOR     (FEET+FT/SEC)      533.0          536.0          2835.1          -    2.086    -    1.293    -    0.945
MATRIX NO. 3   (N.M.+FT/SEC)     0.0877         0.0882          0.4666          -    2.086    -    1.293    -    0.945
               (N.M.+FT/SEC)                    0.4829                                                2.630
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TABLE 7.21 UNCERTAINTY COVARIANCE MATRICES AT TEI CUTOFF

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POSITION AND VELOCITY UNCERTAINTIES ALONG LOCAL AXES AT TIME = 0 HR, 11 MIN, 36.000 SECS (696.000 SECS)

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	POSITION UNCERTAINTIES IN FEET (REL.TO ACT.AXES AT DES.ALTITUDE) ALT.	TRACK	RANGE	VELOCITY UNCERTAINTIES IN FT/SEC (REL.TO ACT.AXES AT DES.ALTITUDE) ALT.	TRACK	RANGE
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED WITH GYRO DRIFT ANGLES) ABOUT STABLE MEMBER AXES							
ABOUT XSM	40.0 SECS	0.0	1011.4	26.0	0.671	4.045	0.194
ABOUT YSM	40.0 SECS	0.0	-32.7	-59.9	-59.918	-0.029	4.970
ABOUT ZSM	40.0 SECS	0.0	1925.0	47.7	-0.985	4.466	0.398
ACCELEROMETER INPUT AXIS MISALIGNMENTS							
X ABOUT Y	28.3 SECS	0.0	20.7	-649.4	-11.016	0.083	-1.346
X ABOUT Z	20.0 SECS	0.0	-0.5	15.0	0.285	-0.001	0.014
Y ABOUT X	20.0 SECS	0.0	505.1	20.4	-0.112	2.021	0.135
Y ABOUT Z	20.0 SECS	0.0	-962.0	-38.8	0.208	-2.232	-0.067
Z ABOUT X	20.0 SECS	0.0	0.6	-7.4	0.447	0.002	-0.077
Z ABOUT Y	0.0 SECS	0.0	0.0	0.0	0.000	0.000	0.000
ACCELEROMETER BIAS							
ACBX	0.200 CM/S.SQ	0.0	43.1	-1359.6	-22.893	0.115	-1.193
ACBY	0.200 CM/S.SQ	0.0	-1493.9	-60.3	0.327	-4.025	-0.044
ACBZ	0.200 CM/S.SQ	0.0	48.0	-666.1	34.477	0.130	-5.856
ACCELEROMETER SCALE FACTOR UNCERTAINTIES							
SFUX	116.0 PPM	0.0	33.1	-1047.2	-17.516	0.076	-0.491
SFUY	116.0 PPM	0.0	-19.7	-0.8	0.004	-0.063	-0.003
SFUZ	116.0 PPM	0.0	19.1	-269.6	13.824	0.076	-2.736
GYRO BIAS DRIFT (45 MIN.DRIFT TIME BEFORE TRAJ.START RESULTING IN 0.393 MR. INITIAL MLM. ABOUT EACH S.M. AXIS)							
NBDXINIT	2.0 MERU	0.0	2053.6	52.8	1.365	8.213	0.720
NBDXFLGT	(0.102 MR.DRIFT	0.0	256.1	9.7	0.006	1.423	0.059
NBDXCOMB	SINCE TRAJ.START)	0.0	2309.7	62.6	1.372	9.636	1.001
NBDYINIT	2.0 MERU	0.0	-66.3	-121.7	-121.780	-0.059	9.071
NBDYFLGT	(0.102 MR.DRIFT	0.0	-2.7	-88.4	-11.112	0.008	0.509
NBDYCOMB	SINCE TRAJ.START)	0.0	-69.0	-210.1	-132.945	-0.052	9.088
NBDZINIT	2.0 MERU	0.0	3908.8	96.9	-1.994	9.069	1.212
NBDZFLGT	(0.102 MR.DRIFT	0.0	324.0	12.0	-0.109	1.080	0.036
NBDZCOMB	SINCE TRAJ.START)	0.0	4232.8	109.0	-2.101	10.150	1.436
GYRO ACCELERATION SENSITIVE DRIFT							
ADX-TERMS	8.0, 5.0 MERU/G	0.0	1384.7	24.7	1.437	7.674	0.597
ADY-TERMS	8.0, 5.0 MERU/G	0.0	3.4	181.2	18.918	0.028	0.504
ADZ-TERMS	8.0, 5.0 MERU/G	0.0	799.9	9.3	0.888	2.811	0.039
GYRO ACCELERATION SQUARED SENSITIVE DRIFT							
ADIXX	0.2 MERU/GSQ	0.0	94.1	0.7	0.149	0.509	-0.008
ADSYY	0.2 MERU/GSQ	0.0	-0.1	-14.5	-1.196	0.003	0.001
ADIZZ	0.2 MERU/GSQ	0.0	31.7	-2.1	-0.064	0.124	-0.006
RSS UNCERT.(FT AND FT/SEC)		0.0	5828.6	2012.7	154.882	18.016	12.517
RSS TKG.UPDATE UNCERT.		0.0	1468.2	505.5	6.545	1.676	1.106
OVERALL RSS UNCERTAINTIES		0.0	6010.7	2075.2	155.020	18.094	12.566

TABLE 7.22 POSITION AND VELOCITY UNCERTAINTIES AT REENTRY END

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POSIT.AND VELOC.UNCERT.ALONG LOCAL ALTITUDE, EAST, NORTH AXES AT TIME = 0 HR, 11 MIN, 36.000 SEC (696.000 SECS)

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	POSITION UNCERTAINTIES IN FEET (REL.TO ACT.AXES AT DES.ALTITUDE) ALT.	EAST	NORTH	VELOCITY UNCERTAINTIES IN FT/SEC (REL.TO ACT.AXES AT DES.ALTITUDE) ALT.	EAST	NORTH
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED WITH GYRO DRIFT ANGLES) ABOUT STABLE MEMBER AXES							
ABOUT XSM	40.0 SECS	0.0	-461.9	-895.8	0.670	-1.833	-3.650
ABOUT YSM	40.0 SECS	0.0	295.2	-500.3	-59.904	-0.551	6.075
ABOUT ZSM	40.0 SECS	0.0	-868.2	-1725.2	-0.990	-2.035	-3.871
ACCELEROMETER INPUT AXIS MISALIGNMENTS							
X ABOUT Y	28.3 SECS	0.0	-522.6	192.6	-11.004	-2.095	2.170
X ABOUT Z	20.0 SECS	0.0	11.8	-4.1	0.285	0.038	-0.048
Y ABOUT X	20.0 SECS	0.0	-221.7	-455.0	-0.114	-0.887	-1.807
Y ABOUT Z	20.0 SECS	0.0	422.3	866.7	0.210	0.980	2.008
Z ABOUT X	20.0 SECS	0.0	-9.2	7.1	0.447	-0.029	-0.031
Z ABOUT Y	0.0 SECS	0.0	0.0	0.0	0.000	0.000	0.000
ACCELEROMETER BIAS							
ACBX	0.200 CM/S.SQ	0.0	-1089.2	395.5	-22.860	-2.932	3.906
ACBY	0.200 CM/S.SQ	0.0	655.8	1345.8	0.329	1.767	3.636
ACBZ	0.200 CM/S.SQ	0.0	-800.6	596.5	34.445	-2.154	-2.684
ACCELEROMETER SCALE FACTOR UNCERTAINTIES							
SFUX	116.0 PPM	0.0	-838.2	303.4	-17.498	-1.939	2.827
SFUY	116.0 PPM	0.0	8.7	17.8	0.004	0.028	0.057
SFUZ	116.0 PPM	0.0	-319.7	234.7	13.818	-1.268	-0.776
GYRO BIAS DRIFT (45 MIN.DRIFT TIME BEFORE TRAJ.START RESULTING IN 0.393 MR. INITIAL MLM. ABOUT EACH S.M. AXIS)							
NBDXINIT	2.0 MERU	0.0	-937.9	-1818.9	1.363	-3.721	-7.315
NBDXFLGT	(0.102 MR.DRIFT	0.0	-113.2	-230.0	0.005	-0.643	-1.268
NBDXCOMB	SINCE TRAJ.START)	0.0	-1051.1	-2048.9	1.370	-4.364	-8.518
NBDYINIT	2.0 MERU	0.0	599.4	-1016.0	-121.727	-1.120	11.590
NBDYFLGT	(0.102 MR.DRIFT	0.0	-17.7	-54.2	-11.110	-0.480	1.324
NBDYCOMB	SINCE TRAJ.START)	0.0	581.7	-1070.1	-132.864	-1.600	12.698
NBDZINIT	2.0 MERU	0.0	-1763.0	-3503.0	-2.008	-4.133	-7.771
NBDZFLGT	(0.102 MR.DRIFT	0.0	-143.0	-291.6	-0.109	-0.501	-0.951
NBDZCOMB	SINCE TRAJ.START)	0.0	-1906.0	-3794.6	-2.116	-4.634	-8.674
GYRO ACCELERATION SENSITIVE DRIFT							
ADX-TERMS	8.0, 5.0 MERU/G	0.0	644.4	1217.3	1.432	3.557	7.086
ADY-TERMS	8.0, 5.0 MERU/G	0.0	61.7	77.5	18.911	1.182	2.410
ADZ-TERMS	8.0, 5.0 MERU/G	0.0	383.3	707.2	0.890	1.434	2.336
GYRO ACCELERATION SQUARED SENSITIVE DRIFT							
ADIXX	0.2 MERU/GSQ	0.0	-45.0	-81.7	0.149	-0.239	-0.465
ADSYY	0.2 MERU/GSQ	0.0	-6.6	-3.3	-1.196	-0.098	0.162
ADIZZ	0.2 MERU/GSQ	0.0	-16.6	-27.4	-0.064	-0.069	-0.098
RSS UNCERT.(FT AND FT/SEC)		0.0	3209.8	5407.3	154.791	9.755	22.197
RSS TKG.UPDATE UNCERT.		0.0	1060.4	1111.0	6.546	0.676	2.283
OVERALL RSS UNCERTAINTIES		0.0	3380.4	5520.3	154.929	9.778	22.314

TABLE 7.23 POSITION AND VELOCITY UNCERTAINTIES AT REENTRY END (EAST-NORTH AXES)

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****
UNCERTAINTIES IN (AT TIME = 0 HR, 11 MIN, 36.000 SEC (696.000 SECS))
****

UNCERT. SOURCE	ONE SIGMA UNCERTAINTY	INERTIAL FLIGHT PATH ANGLE (DEG)	INERTIAL VELOCITY (FT/SEC)	INERTIAL AZIMUTH (DEG)	FREE FALL TIME TO NOM. ALT. (SECS)	LATITUDE (DEG)	LONGITUDE (DEG)	RANGE (N.MILE)
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED)								
ABOUT XSM	40.0 SECS	-0.5664	-0.4749	-2.1888	0.0814	-0.0025	-0.0014	-0.15
ABOUT YSM	40.0 SECS	-0.3696	-2.5682	-0.6006	-7.2315	-0.0014	0.0009	-0.08
ABOUT ZSM	40.0 SECS	-0.6375	-0.5928	-2.4578	-0.1201	-0.0047	-0.0027	-0.28
ACCELEROMETER INPUT AXIS MISALIGNMENTS								
X ABOUT Y	28.3 SECS	0.0856	0.1746	-2.2808	-1.2788	0.0005	-0.0016	0.03
X ABOUT Z	20.0 SECS	-0.0009	0.0052	0.0425	0.0341	0.0000	0.0000	0.00
Y ABOUT X	20.0 SECS	-0.2899	-0.2585	-1.0213	-0.0131	-0.0012	-0.0007	-0.07
Y ABOUT Z	20.0 SECS	0.3240	0.3119	1.0504	0.0258	0.0024	0.0013	0.14
Z ABOUT X	20.0 SECS	0.0055	0.0153	-0.0325	0.0538	0.0000	0.0000	0.00
Z ABOUT Y	0.0 SECS	0.0000	0.0000	0.0000	0.0258	0.0000	0.0000	0.00
ACCELEROMETER BIAS								
ACBXINIT		0.0000	0.0000	0.0000	-0.0071	0.0000	0.0000	0.00
ACBXFLGT	0.200 CM/S.SQ	0.0822	-0.8200	-3.1741	-2.7827	0.0011	-0.0034	0.07
ACBXCOMB		0.0822	-0.8200	-3.1741	-2.7827	0.0011	-0.0034	0.07
ACBYINIT		0.0000	0.0000	0.0000	-0.0071	0.0000	0.0000	0.00
ACBYFLGT	0.200 CM/S.SQ	0.5852	0.5647	1.8374	0.0400	0.0037	0.0020	0.22
ACBYCOMB		0.5852	0.5647	1.8374	0.0400	0.0037	0.0020	0.22
ACBZINIT		0.0000	0.0000	0.0000	-0.0071	0.0000	0.0000	0.00
ACBZFLGT	0.200 CM/S.SQ	0.4173	1.7384	-2.3508	4.2305	0.0016	-0.0025	0.10
ACBZCOMB		0.4173	1.7384	-2.3508	4.2305	0.0016	-0.0025	0.10
ACCELEROMETER SCALE FACTOR UNCERTAINTIES								
SFUX	116.0 PPM	0.0392	-0.9075	-2.1205	-2.1627	0.0008	-0.0026	0.05
SFUY	116.0 PPM	0.0091	0.0083	0.0309	0.0005	0.0000	0.0000	0.00
SFUZ	116.0 PPM	0.2069	0.0892	-1.3924	1.6190	0.0006	-0.0010	0.04
GYRO BIAS DRIFT								
NBDXINIT		-1.1383	-0.9168	-4.8177	0.1657	-0.0050	-0.0029	-0.30
NBDXFLGT	2.0 MERU	-0.2015	-0.2021	-0.7316	-0.0017	-0.0006	-0.0004	-0.04
NBDXCOMB		-1.3313	-1.0864	-5.8161	0.1641	-0.0056	-0.0033	-0.34
NBDYINIT		-0.7431	-5.2117	-1.2113	-14.5539	-0.0028	0.0019	-0.17
NBDYFLGT	2.0 MERU	-0.0473	0.0961	-0.5285	-1.2856	-0.0001	-0.0001	-0.01
NBDYCOMB		-0.7870	-5.1140	-1.7273	-15.7737	-0.0029	0.0018	-0.18
NBDZINIT		-1.2786	-1.1446	-5.4625	-0.2432	-0.0096	-0.0055	-0.58
NBDZFLGT	2.0 MERU	-0.1537	-0.1225	-0.5669	-0.0109	-0.0008	-0.0004	-0.05
NBDZCOMB		-1.4244	-1.2394	-6.2605	-0.2539	-0.0104	-0.0059	-0.62
GYRO ACCELERATION SENSITIVE DRIFT (RSS OF UNCERTAINTIES DUE TO ADIA, ADSRA AND ADDA UNCERTAINTIES FOR EACH GYRO)								
ADX-TERMS 8.0, 5.0 MERU/G		1.0853	1.1121	3.4904	0.1624	0.0033	0.0020	0.20
ADY-TERMS 8.0, 5.0 MERU/G		0.0580	0.5106	1.2953	2.1517	0.0002	0.0002	0.01
ADZ-TERMS 8.0, 5.0 MERU/G		0.3914	0.2913	1.6635	0.0975	0.0019	0.0011	0.11
RSS UNCERTAINTIES		2.7184	6.5362	11.7040	18.4621	0.0148	0.0100	0.89

TABLE 7.24 OTHER UNCERTAINTIES AT REENTRY END

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INITIAL S.M.MLMS. AND DRIFT ANGLES SUMMARY (S.M.ANGLES AXI= 0.000, AYPI=- 90.857, AZSM= 0.000 DEG)(T= 696.000 SEC)

UNCERT. SOURCE	ONE SIGMA UNCERT.VALUE		MLM. ANGLE ABOUT STABLE MEMBER AXES XSM	MR. YSM	ZSM	MLM.ANGLE ABOUT LOCAL VERTICAL AXES ALT.	MR. TRACK	RANGE
INITIAL STABLE MEMBER MISALIGNMENTS (UNCORRELATED WITH GYRO DRIFT ANGLES) ABOUT								
ABOUT XSM	40	SECS	0.1939	0.0000	0.0000	0.1105	0.1427	- 0.0707
ABOUT YSM	40	SECS	0.0000	0.1939	0.0000	- 0.0016	- 0.0850	- 0.1742
ABOUT ZSM	40	SECS	0.0000	0.0000	0.1939	- 0.1593	0.0999	- 0.0472
INITIAL S.M. MLMS. AT TRAJ. START DUE TO GYRO BIAS DRIFT FOR 45 MINS. PRIOR TO START OF TRAJECTORY								
NBDX	2.0	MERU	0.3937	0.0000	0.0000	0.2245	0.2898	- 0.1436
NBDY	2.0	MERU	0.0000	0.3937	0.0000	- 0.0033	- 0.1727	- 0.3538
NBDZ	2.0	MERU	0.0000	0.0000	0.3937	- 0.3234	0.2029	- 0.0960
RSS INITIAL S.M. MLMS.			0.4389	0.4389	0.4389	0.4389	0.4389	0.4389
DRIFT ANGLES DUE TO GYRO DRIFT AFTER TRAJECTORY START								
NBDX	2.0	MERU	0.1015	0.0000	0.0000	0.0578	0.0747	- 0.0370
NBDY	2.0	MERU	0.0000	0.1015	0.0000	- 0.0008	- 0.0445	- 0.0912
NBDZ	2.0	MERU	0.0000	0.0000	- 0.1015	0.0833	- 0.0523	0.0247
ADIAX	8.0	MERU/G	- 0.4845	0.0000	0.0000	- 0.2762	- 0.3566	0.1766
ADSRAX	5.0	MERU/G	0.0071	0.0000	0.0000	0.0041	0.0052	- 0.0026
ADOAX	1.0	MERU/G	- 0.0505	0.0000	0.0000	- 0.0288	- 0.0372	0.0184
ADIAY	8.0	MERU/G	0.0000	- 0.0115	0.0000	0.0000	0.0050	0.0103
ADSRAY	5.0	MERU/G	0.0000	0.2529	0.0000	- 0.0021	- 0.1109	- 0.2273
ADOAY	1.0	MERU/G	0.0000	- 0.0605	0.0000	0.0005	0.0265	0.0544
ADIAZ	8.0	MERU/G	0.0000	0.0000	- 0.4047	0.3325	- 0.2086	0.0987
ADSRAZ	5.0	MERU/G	0.0000	0.0000	- 0.0071	0.0059	- 0.0037	0.0017
ADOAZ	1.0	MERU/G	0.0000	0.0000	0.0605	- 0.0497	0.0312	- 0.0147
ADIXX	0.2	MERU/GSQ	0.0324	0.0000	0.0000	0.0185	0.0239	- 0.0118
ADSYY	0.2	MERU/GSQ	0.0000	0.0204	0.0000	- 0.0001	- 0.0089	- 0.0183
ADIZZ	0.2	MERU/GSQ	0.0000	0.0000	- 0.0204	0.0167	- 0.0105	0.0049
RSS DRIFT ANGLE			0.4987	0.2802	0.4222	0.4485	0.4441	0.3272
OVERALL RSS MLM			0.6643	0.5207	0.6090	0.6275	0.6244	0.5474

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