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DISPERSION ANALYSIS FOR BASELINE REFERENCE MISSION 1

MISSION PLANNING, MISSION ANALYSIS AND SOFTWARE FORMULATION

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1.0 INTRODUCTION

A dispersion analysis considering 3σ uncertainties (or perturbations) in platform, vehicle, and environmental parameters has been performed for baseline reference mission (BRM) 1. The dispersion analysis is based on the nominal trajectory for BRM 1 which is described in Reference 1. The analysis has been performed to determine state vector and performance dispersions (or variations) which result from the indicated 3σ uncertainties. The dispersions are determined at major mission events and fixed times from lift-off (time slices). The dispersion results will be used to evaluate the capability of the vehicle to perform the mission within a 3σ level of confidence and to determine flight performance reserves (FPR).

2.0 DISCUSSION

2.1 Groundrules and Assumptions

The groundrules describing the Reference 1 ascent trajectory are used for this dispersion analysis. In addition, the following assumptions are made:

a. Dispersion analysis simulations are generated using the Space Vehicle Dynamics Simulation (SVDS) program operating in a three-degree-of-freedom flight simulation mode.

b. Dispersion analysis results are based on the nominal mission for BRM 1.

c. Space shuttle main engine (SSME) thrust reduction (maximum rated power level to nominal power level) occurs at a fixed time from liftoff for all perturbation simulations.

d. First stage steering is defined by vehicle attitude as a function of relative velocity from the nominal profile. This attitude history is used to provide steering commands for all perturbation simulations.

e. The perturbations considered for evaluation in this dispersion analysis are assumed normally distributed about their statistical mean.

f. The perturbations are statistically independent.

g. The perturbations considered include error sources in guidance and propulsion systems, uncertainties in measurements of system properties and perturbations in nominal environmental conditions.

2.2 General

2.2.1 Simulation Techniques

A dispersion analysis is based on a nominal trajectory generated without including the effects of any uncertainties. Performance-optimum first stage steering commands and second stage guidance inputs are determined for the nominal profile. The nominal steering and guidance inputs are then used in simulating trajectories with perturbations since perturbations are unplanned occurrences.

The perturbation simulations in this analysis are determined by independently simulating 3σ values of the indicated uncertainties. That is, a complete trajectory simulation (liftoff to insertion) is developed using only one error source. The dispersion results from these independent simulations are then statistically correlated by 1) a root-sum-square (RSS) process and 2) determining a covariance matrix indicative of all error sources.

2.2.2 Error Sources, Symbols and Definitions

A list of the error sources used in this study and their 3σ values is given in Table I. Included in Table I are symbols used in the RSS data tables to identify dispersions resulting from the error sources.

Figure 1 contains the definition of a local horizontal coordinate system (LHS). The RSS data and covariance matrices of this study indicate state vector dispersions in the LHS. Since the LHS is determined from the nominal state, a different LHS is determined at each instance for which RSS or covariance data is required.

Tables II and III contain symbols used to identify elements of the covariance matrices, a definition of the symbols, and the format of the covariance matrices. Although 3σ values of the error sources are used in the trajectory simulations, state vector dispersions are adjusted to a 1σ level for determining the covariance matrices.

2.2.3 Events and Time Slices for Dispersion Analysis

RSS and covariance matrix data are presented for several events and time slices in this analysis. An event is defined as a fixed occurrence (sensed by attaining a given target value) and may have a time-from-liftoff dispersion associated with it. A time slice is indicative of a fixed time from liftoff.

The events and time slices for which RSS and covariance matrix data are presented are as follows:

a. Solid Rocket Booster (SRB) Separation (See Table IV-A, IV-B)

b. Main Engine Cutoff (MECO) (See Tables V-A, V-B)

c. Time slice defined as nominal MECO time plus 25 seconds, 506.6 seconds from liftoff (See Tables VI-A, VI-B)

d. Insertion (See Tables VII-A, VII-B)

e. Time slice defined as nominal insertion time plus 25 seconds, 686.2 seconds from liftoff (See Tables VIII-A, VIII-B)

As previously stated, the LHS in which state vector dispersions (RSS data and covariance matrix data) are calculated is determined by the nominal state at each of the indicated events and time slices. Each event and time slice has its own LHS in which dispersions are presented.

2.3 RSS Data

The RSS technique is the method used in this analysis to statistically combine dispersions in flight parameters to determine the 3-sigma limits in the significant parameters. In actual vehicle flight, there is a 99.73 percent probability that the value of the parameter will be inside the 3-sigma band (the RSS value) if all assumptions required for this method are justified.

Inherent in the RSS method are the assumptions of linearity and normality. These assumptions are as follows:

a. The perturbations are statistically independent; that is, the occurrence of one perturbation will not affect the probability of a second perturbation.

b. A perturbation and its associated flight dispersions are linearly related.

RSS data presented in this report includes dispersions in altitude, down range and cross range position, and cross range rate computed in the LHS. Speed, flight-path angle, altitude rate, time and total vehicle weight dispersions are also included in the RSS data. The dispersions presented in the RSS data are computed as:

dispersion = (Actual integrated state of perturbed trajectory) - (nominal trajectory state).

RSS data are presented in Tables IV-A through VIII-A for the major events and time slices defined in Section 2.2.3. Data are included in the tables to indicate parameter dispersions for each individual error source and the RSS combination of the dispersions. As previously stated, this study assumes all error sources to be normally distributed. Consequently, the RSS data indicated in Tables IV-A through VIII-A are computed from the dispersions without regard to signs.

RSS data at SRB separation (Table IV-A) and MECO (Table V-A) contain total vehicle weight dispersions and the resulting penalty in terms of orbiter main engine propellant. The propellant variations will be used to indicate whether the cumulative penalty is within the flight performance reserve (FRP) requirements.

RSS data Tables VI-A through VIII-A contain OMS propellant dispersions.

2.4 Covariance Matrix Data

The covariance matrix represents a multivariate normal distribution of a 6 by 1 vector of dispersions in the actual (integrated) state, a 6 by 1 vector of navigated state deviations, and vehicle weight. The navigated state deviations represented in the covariance matrix are computed as:

deviation = (perturbed navigated state) - (actual integrated state of perturbed trajectory).

Table II defines the parameters presented in the covariance matrices of this paper. The matrices are expressed in the LHS (UVW coordinates) defined by the nominal state vector at each event or time slice. (See Figure 1.) The covariance matrices are indicative of 1σ perturbations. Each diagonal element of the matrix (Table III) represents the variance of the associated parameter. For example, the element in the second row and second column represents the variance of the actual state in the V (or down-range) direction. Each off-diagonal element represents the covariance between the diagonal elements directly above and directly to the right of it. For example, the element in the fourth row and second column represents the covariance between the down-range variance and the $\dot{U}$ variance.

The elements of the matrix are symbolically defined in Table III. The matrices are given in Tables IV-B through VIII-B. Since a covariance matrix is symmetrical, only the lower triangle of the matrices is given.

2.5 Exchange Ratios

An exchange ratio is defined to be the ratio of a dispersion in a given variable to the magnitude of the error source causing the dispersion. The use of exchange ratios enables a quick-look assessment of the variations from nominal which may be expected to result from the application of error sources of various magnitudes. To use an exchange ratio, multiply a change in a parameter by its corresponding exchange ratio. This defines the predicted performance variation at the event or time slice for which the ratio has been calculated.

Table IX contains exchange ratios indicating SSME propellant dispersion at MECO for several performance error sources. The exchange ratios are valid for perturbations only within a specified range. The exchange ratios show a sensitivity to an unplanned anomaly; that is, the trajectory is not optimized for the uncertainties. These exchange ratios may be used to predict SSME propellant variations at MECO.

2.6 RSS Summary Data

Summary tables of the RSS data are given in Tables X and XI. Table X contains the RSS data of Tables IV-A through VIII-A. Data are presented for each event and time slice indicated in the tables. The variations indicated by Table X are dispersions of the actual (integrated) perturbed state from the nominal state. Table XI is the RSS of navigation deviations computed as defined in Section 2.4. Data are presented in Table XI for each event and time slice indicated by Tables IV-B through VIII-B. In considering the data of Tables X and XI, it should be noted that uncertainties in atmospheric winds and SSME thrust tailoff are not simulated. These uncertainties are major contributors to position errors at SRB separation and MECO, respectively. Results of these error sources will be included in the dispersion analyses at a later date.

3.0 CONCLUSIONS

Data presented in this study are based on the SVDS program which has been verified as a dispersion analysis tool. (See References 2 and 3.)

Principal error contributors to the covariance matrix at MECO are listed in Table XII. The dispersion data indicate that the largest position error occurs in the down range component. At MECO the vehicle performance uncertainties are the major contributors to down range error.

4.0 RECOMMENDATIONS

For future dispersion analyses, further refinements and investigation are recommended for the following items:

a. Dispersion analyses should include abort once-around (AOA) simulations since FPR and fuel bias requirements vary between the nominal and AOA flights.

b. In order to provide a complete analysis, the dispersion simulations may be expanded to the entry-interface point.

c. Include atmospheric winds and SSME thrust tailoff as simulated uncertainties.

5.0 REFERENCES

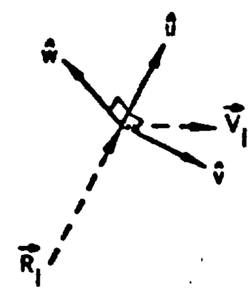
1. JSC Internal Note No. 73-FM-47, "Space Shuttle System Baseline Reference Missions, Volume I - Mission 1, Revision 2", dated 7 July 1975.
2. Design Note No. 1.4-7-7, "Dispersion Analysis and Linear Error Analysis Capabilities of the Space Vehicle Dynamics Simulation Program", dated 12 May 1975.
3. Design Note No. 1.4-7-14, "Dispersion Analyses Techniques Within The Space Vehicle Dynamics Simulation Program, Revision A", dated 25 September 1975.

TABLE 1

ERROR SOURCE DEFINITIONS

ERROR SOURCE SYMBOLS*	DEFINITION	3-SIGMA VALUES	UNITS
PLATFORM ALINE	INITIAL PLATFORM MISALIGNMENT AZIMUTH TILT,ROLL	 180.000 60.000	 ARC SEC ARC SEC
DRIFT BIAS	FREE GYRO BIAS	.095	DEG/HR
G-SENS IA DRIFT	GYRO INPUT AXIS ACCELERATION SENSITIVE DRIFT	.075	DEG/HR/G
G-SENS SA DRIFT	GYRO SPIN AXIS ACCELERATION SENSITIVE DRIFT	.075	DEG/HR/G
G-SENS OA DRIFT	GYRO OUTPUT AXIS ACCELERATION SENSITIVE DRIFT	.075	DEG/HR/G
G-SENS-SQ DRIFT	GYRO ACCELERATION SQUARED SENSITIVE DRIFT	.075	DEG/HR/G**2
ACCEL BIAS	ACCELEROMETER BIAS	150.000	MICRO-G
ACCEL SCALE FAC	ACCELEROMETER SCALE FACTOR	120.000	PPM
ACCEL IA ALINE	ACCELEROMETER INPUT AXIS MISALIGNMENT		
- TOWARD OA - TOWARD SA	-TOWARD OUTPUT AXIS -TOWARD SPIN AXIS	45.000 45.000	ARC SEC ARC SEC
WEB ACT	POS. WEB ACTION TIME	4.710	PERCENT
S ISP	NEG. SRB SPECIFIC IMPULSE	.500	PERCENT
S PROP	NEG. SRB PROPELLANT LOADING	.210	PERCENT
S INERT	POS. SRB INERT WEIGHT	.850 (2978.250)	PERCENT (LB)
O THRST	NEG. ORBITER THRUST	6000.000 (10392.000)	LB/ENG (LB/3 ENG)
O ISP	NEG. ORBITER SPECIFIC IMPULSE	2.300 (1.328)	SEC-1 ENG (SEC/3 ENG)
O INERT	POS. ORBITER INERT WEIGHT	.810 (1215.000)	PERCENT (LB)
ET INERT	POS. EXTERNAL TANK INERT WEIGHT	.810 (577.449)	PERCENT (LB)
ET PROP	NEG. EXTERNAL TANK PROPELLANT LOADING	.400 (7422.400)	PERCENT (LB)
AX FR	POS. AXIAL FORCE	ROCKWELL DOCUMENT NO. SD-72-SH-0060-2G JUNE 1974, AERODYNAMIC DESIGN DATA BOOK, VOL. II	
B DRAG	POS. BASE DRAG	ROCKWELL DOCUMENT NO. SD-72-SH-0060-2G JUNE 1974, AERODYNAMIC DESIGN DATA BOOK, VOL. II	

* Symbols used in Tables IV-A through XIII-A.



Let R_I be the inertial position vector and V_I be the inertial velocity vector. The LHS coordinate system is defined by the following three vector equations.

$$\hat{u} = \vec{R}_I/|\vec{R}_I|$$

$$\hat{v} = (\vec{R}_I \times \vec{V}_I \times \vec{R}_I)/|\vec{R}_I \times \vec{V}_I \times \vec{R}_I|$$

$$\hat{w} = \hat{u} \times \hat{v}$$

Figure 1 - Local Horizontal Coordinate System

TABLE II

Covariance Matrix Parameter Definition

State Vector Component	Definition	Units
U ACT V ACT W ACT	Actual state vector position component dispersions in the Local Horizontal Coordinate System (LHS)	FT
U-DOT ACT V-DOT ACT W-DOT ACT	Actual state vector velocity component dispersions in the LHS	FT/SEC
U NAV V NAV W NAV	Navigated state vector position component deviations in a LHS*	FT
U-DOT NAV V-DOT NAV W-DOT NAV	Navigated state vector velocity component deviations in a LHS*	FT/SEC
WT	Vehicle weight	LB

* The navigated state has its own LHS developed from the nominal navigated state vectors similar to the actual state LHS development. Navigated state vector deviations are computed as:

deviation = (perturbed navigated state) - (actual integrated state of perturbed trajectory)

TABLE III

Covariance Matrix Format

U ACT	σ_u^2												
V ACT	$\sigma_u\sigma_v$	σ_v^2											
W ACT	$\sigma_u\sigma_w$	$\sigma_v\sigma_w$	σ_w^2										
U-DOT ACT	$\sigma_u\sigma_{\dot{u}}$	$\sigma_v\sigma_{\dot{u}}$	$\sigma_w\sigma_{\dot{u}}$	$\sigma_{\dot{u}}^2$									
V-DOT ACT	$\sigma_u\sigma_{\dot{v}}$	$\sigma_v\sigma_{\dot{v}}$	$\sigma_w\sigma_{\dot{v}}$	$\sigma_{\dot{u}}\sigma_{\dot{v}}$	$\sigma_{\dot{v}}^2$								
W-DOT ACT	$\sigma_u\sigma_{\dot{w}}$	$\sigma_u\sigma_{\dot{w}}$	$\sigma_w\sigma_{\dot{w}}$	$\sigma_{\dot{u}}\sigma_{\dot{w}}$	$\sigma_{\dot{v}}\sigma_{\dot{w}}$	$\sigma_{\dot{w}}^2$							
U NAV	$\sigma_u\sigma_{u'}$	$\sigma_v\sigma_{u'}$	$\sigma_w\sigma_{u'}$	$\sigma_{\dot{u}}\sigma_{u'}$	$\sigma_{\dot{v}}\sigma_{u'}$	$\sigma_{\dot{w}}\sigma_{u'}$	$\sigma_{u'}^2$						
V NAV	$\sigma_u\sigma_{v'}$	$\sigma_v\sigma_{v'}$	$\sigma_w\sigma_{v'}$	$\sigma_{\dot{u}}\sigma_{v'}$	$\sigma_{\dot{v}}\sigma_{v'}$	$\sigma_{\dot{w}}\sigma_{v'}$	$\sigma_{u'}\sigma_{v'}$	$\sigma_{v'}^2$					
W NAV	$\sigma_u\sigma_{w'}$	$\sigma_v\sigma_{w'}$	$\sigma_w\sigma_{w'}$	$\sigma_{\dot{u}}\sigma_{w'}$	$\sigma_{\dot{v}}\sigma_{w'}$	$\sigma_{\dot{w}}\sigma_{w'}$	$\sigma_{u'}\sigma_{w'}$	$\sigma_{v'}\sigma_{w'}$	$\sigma_{w'}^2$				
U-DOT NAV	$\sigma_u\sigma_{\dot{u}'}$	$\sigma_v\sigma_{\dot{u}'}$	$\sigma_w\sigma_{\dot{u}'}$	$\sigma_{\dot{u}}\sigma_{\dot{u}'}$	$\sigma_{\dot{v}}\sigma_{\dot{u}'}$	$\sigma_{\dot{w}}\sigma_{\dot{u}'}$	$\sigma_{u'}\sigma_{\dot{u}'}$	$\sigma_{v'}\sigma_{\dot{u}'}$	$\sigma_{w'}\sigma_{\dot{u}'}$	$\sigma_{\dot{u}'}^2$			
V-DOT NAV	$\sigma_u\sigma_{\dot{v}'}$	$\sigma_v\sigma_{\dot{v}'}$	$\sigma_w\sigma_{\dot{v}'}$	$\sigma_{\dot{u}}\sigma_{\dot{v}'}$	$\sigma_{\dot{v}}\sigma_{\dot{v}'}$	$\sigma_{\dot{w}}\sigma_{\dot{v}'}$	$\sigma_{u'}\sigma_{\dot{v}'}$	$\sigma_{v'}\sigma_{\dot{v}'}$	$\sigma_{w'}\sigma_{\dot{v}'}$	$\sigma_{\dot{u}'}\sigma_{\dot{v}'}$	$\sigma_{\dot{v}'}^2$		
W-DOT NAV	$\sigma_u\sigma_{\dot{w}'}$	$\sigma_v\sigma_{\dot{w}'}$	$\sigma_w\sigma_{\dot{w}'}$	$\sigma_{\dot{u}}\sigma_{\dot{w}'}$	$\sigma_{\dot{v}}\sigma_{\dot{w}'}$	$\sigma_{\dot{w}}\sigma_{\dot{w}'}$	$\sigma_{u'}\sigma_{\dot{w}'}$	$\sigma_{v'}\sigma_{\dot{w}'}$	$\sigma_{w'}\sigma_{\dot{w}'}$	$\sigma_{\dot{u}'}\sigma_{\dot{w}'}$	$\sigma_{\dot{v}'}\sigma_{\dot{w}'}$	$\sigma_{\dot{w}'}^2$	
WT	$\sigma_u\sigma_{w_t}$	$\sigma_v\sigma_{w_t}$	$\sigma_w\sigma_{w_t}$	$\sigma_{\dot{u}}\sigma_{w_t}$	$\sigma_{\dot{v}}\sigma_{w_t}$	$\sigma_{\dot{w}}\sigma_{w_t}$	$\sigma_{u'}\sigma_{w_t}$	$\sigma_{v'}\sigma_{w_t}$	$\sigma_{w'}\sigma_{w_t}$	$\sigma_{\dot{u}'}\sigma_{w_t}$	$\sigma_{\dot{v}'}\sigma_{w_t}$	$\sigma_{\dot{w}'}\sigma_{w_t}$	$\sigma_{w_t}^2$

Notes:
a. Unprimed symbols represent actual (integrated) state vector errors.
b. Primed symbols represent navigation state vector error.
c. W_t represents total vehicle weight error.

TABLE IV-A
LINEAR ERROR ANALYSIS
RSS DATA AT SRB SEPARATION (EVENT)

	ALTITUDE FT	DOWN RANGE FT	CROSS RANGE FT	SPEED FPS	FLIGHT PATH ANGLE-DEG	ALTITUDE RATE-FPS	CROSS RANGE RATE-FPS	TIME SEC	WEIGHT LB	SSME PROP LB
PLATFORM ALINE										
AZIMUTH	-0.	-1.	136.	-.0	-.000	-.0	3.7	.0	0.	0.
TILT	44.	-81.	-0.	-.8	.015	1.2	-.0	.0	0.	0.
ROLL	0.	1.	-95.	.0	.000	.0	-1.6	.0	0.	0.
DRIFT BIAS										
X	-0.	-0.	2.	-.0	.000	-.0	.1	.0	0.	0.
Y	4.	-3.	0.	-.0	-.001	.1	-.0	.0	0.	0.
Z	-0.	0.	-3.	.0	-.000	.0	-.1	.0	0.	0.
G-SENS IA DRIFT										
X	-0.	-0.	6.	-.0	-.000	-.0	.2	.0	0.	0.
Y	0.	0.	0.	.0	.000	.0	.0	.0	0.	0.
Z	-0.	-0.	-2.	.0	.000	.0	-.1	.0	0.	0.
G-SENS SA DRIFT										
X	0.	0.	0.	.0	.000	.0	.0	.0	0.	0.
Y	2.	-2.	0.	-.0	.001	.1	-.0	.0	0.	0.
Z	0.	0.	-8.	.0	-.006	.0	-.2	.0	0.	0.
G-SENS OA DRIFT										
X	-0.	-0.	2.	-.0	.000	-.0	.1	.0	0.	0.
Y	6.	-7.	0.	-.1	.002	.2	-.0	.0	0.	0.
Z	0.	0.	0.	.0	.000	.0	.0	.0	0.	0.
G-SENS-SQ DRIFT										
X	0.	0.	0.	.0	.000	.0	.0	.0	0.	0.
Y	3.	0.	0.	.0	.000	.0	.0	.0	0.	0.
Z	-3.	0.	-3.	.0	-.000	.0	-.1	.0	0.	0.
ACCEL BIAS										
X	-13.	20.	0.	.2	-.004	-.3	.0	.0	0.	0.
Y	-3.	-0.	0.	-.0	.000	.0	-.0	.0	0.	0.
Z	-9.	13.	0.	.1	-.003	-.2	.0	.0	0.	0.
ACCEL SCALE FAC										
X	-17.	27.	0.	.3	-.005	-.4	.0	.0	0.	0.
Y	-0.	-0.	0.	.0	.000	.0	-.0	.0	0.	0.
Z	-4.	4.	0.	.0	-.001	-.1	.0	.0	0.	0.
ACCEL IA ALINE -TOWARD OA										
X	0.	0.	0.	.0	.000	.0	.0	.0	0.	0.
Y	-0.	-0.	0.	-.0	.000	.0	-.0	.0	0.	0.
Z	-23.	24.	0.	.3	-.007	-.6	.0	.0	0.	0.
-TOWARD SA										
X	-7.	9.	0.	.1	-.002	-.2	.0	.0	0.	0.
Y	-0.	-0.	0.	-.0	.000	.0	-.0	.0	0.	0.
Z	-0.	-0.	0.	.0	.000	.0	-.0	.0	0.	0.
PERFORMANCE										
AEO ACT	1843.	12169.	-130.	-6.3	-.438	-44.9	.2	5.6	-10716.	-18717.
S ISP	-869.	-1627.	-12.	-39.3	.063	-7.5	-.2	-.0	-0.	-0.
S PROP	-211.	-428.	-3.	-10.4	.010	-2.5	-.1	-.0	0.	0.
S INERT	-187.	-379.	-3.	-9.8	.007	-2.6	-.1	.0	4978.	0.
O THRST	-417.	-836.	-6.	-21.6	.017	-5.7	-.1	.0	2732.	2732.
O ISP	31.	58.	0.	2.2	-.001	.4	-.0	-.0	-1183.	-1183.
O INERT	-77.	-155.	-1.	-4.0	.003	-1.1	-.0	.0	1215.	0.
ET INERT	-37.	-74.	-1.	-1.9	.001	-.5	-.0	.0	577.	0.
ET PROP	471.	952.	7.	24.5	-.019	6.5	.1	.0	-7422.	-7422.
AERODYNAMIC										
AX FR	-296.	-589.	-4.	-12.2	.016	-2.8	-.1	.0	0.	0.
B DRAG	-357.	-753.	-5.	-14.3	.027	-2.3	-.1	.0	0.	0.
RSS =	2201.	12422.	212.	56.9	.445	46.7	4.1	5.6	20619.	20355.

TABLE IV-B

COVARIANCE MATRIX

AT SRB SEPARATION

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	5.3043645+05						
V ACT	2.8243537+06	1.7145435+07					
W ACT	-2.4272237+04	-1.7060403+05	4.9782246+03				
U-DOT ACT	-8.3118168+03	-6.1761625+04	7.1572131+02	2.7389645+02			
V-DOT ACT	9.5775465+03	2.9576548+04	-4.4967040+01	1.6460114+01	3.5090769+02		
W-DOT ACT	6.8466527+01	3.8142729+02	7.1371173+01	-7.0680923-01	2.3352075+00	1.8709829+03	
U NAV	-2.6176382+02	1.9563567+03	-9.0710416+00	-1.0045749+01	7.2200869+00	1.6117116-01	7.0709486+02
V NAV	4.0015653+02	-2.4453266+02	1.1440242+01	7.0250272+00	-6.1753074+00	4.2140043-01	-5.1047466+02
W NAV	7.8316551+01	1.0054989+02	-3.1636317+03	1.1047060+00	3.6063954+00	-7.5597664+01	-1.3891754+01
U-DOT NAV	-9.3015277+00	1.5230577+01	2.9151450-01	-2.9157071-01	2.4810116-01	6.3149986-03	1.5537039+01
V-DOT NAV	5.6172705+00	-1.1130632+01	3.8496177-01	1.3155578-01	-1.5269933-01	1.0321721-02	-8.1321949+00
W-DOT NAV	2.3605085-01	3.7785724-01	-7.4776402+01	5.9487810-03	1.1650378-02	-1.8676907+00	-2.3698803-01
WT	-4.4265519+06	-2.6503825+07	2.6134716+05	9.2261444+04	-5.1821714+04	-6.3084732+02	-2.5833872+03

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT
V NAV	2.1552075+03					
W NAV	-1.2725586+01	4.2842766+03				
U-DOT NAV	-1.4777429+01	-3.7203280-01	3.6534756-01			
V-DOT NAV	3.4736552+01	-3.6203401-01	-2.3653290-01	5.6584565-01		
W-DOT NAV	-3.7562193-01	9.3643520+01	-6.7908927-03	-9.8537253-03	2.1972189+00	
WT	-7.5617301+02	4.2431419+02	7.0427964-01	-2.9524598-01	9.5974190-02	4.7213920+07

TABLE V-A

LINEAR ERROR ANALYSIS

RSS DATA AT MECO (EVENT)

	ALTITUDE FT	DOWN RANGE FT	CROSS RANGE FT	SPEED FPS	FLIGHT PATH ANGLE-DEG	ALTITUDE RATE-FPS	CROSS RANGE RATE-FPS	TIME SEC	WEIGHT LB	SSME PROP LB
PLATFORM ALINE										
AZIMUTH	-13.	-2.	3902.	-.0	-.000	-.1	19.9	.0	-0.	-0.
TILT	1116.	-1098.	4.	-4.0	.011	5.1	.0	-.0	12.	12.
ROLL	7.	-2.	-960.	-.0	.000	.0	-2.4	-.0	0.	0.
DRIFT BIAS										
X	0.	0.	199.	.0	-.000	-.0	1.5	.0	-0.	-0.
Y	189.	-103.	0.	-.6	.003	1.3	.0	-.0	0.	0.
Z	-0.	-1.	-73.	-.0	.000	.0	-.2	-.0	0.	0.
G-SENS IA DRIFT										
X	-0.	-0.	341.	-.0	-.000	-.0	2.1	.0	-0.	-0.
Y	-1.	1.	0.	.0	-.000	-.0	-.0	.0	0.	0.
Z	2.	-0.	-110.	-.0	.000	.0	-.3	.0	-0.	-0.
G-SENS SA DRIFT										
X	-0.	-0.	-1.	-.0	.000	.0	-.0	-.0	0.	0.
Y	351.	-168.	1.	-1.1	.007	2.9	.0	-.0	0.	0.
Z	2.	-0.	-155.	-.0	.000	.0	-.5	-.0	0.	0.
G-SENS OA DRIFT										
X	-1.	0.	374.	-.0	.000	.0	3.1	.0	-0.	-0.
Y	311.	-203.	2.	-.9	.004	1.8	.0	-.0	1.	1.
Z	-0.	-0.	0.	.0	.000	.0	.0	-.0	0.	0.
G-SENS-SO DRIFT										
X	-3.	0.	-0.	.0	.000	.0	-.0	.0	0.	0.
Y	-1.	1.	0.	.0	-.000	-.0	-.0	-.0	0.	0.
Z	1.	-1.	-131.	-.0	.000	.0	-.4	-.0	0.	0.
ACCEL BIAS										
X	-575.	191.	-1.	.5	-.005	-2.3	-.0	-.0	27.	27.
Y	-4.	1.	546.	.0	.000	.0	2.2	.0	-0.	-0.
Z	-134.	-567.	-0.	-2.1	-.003	-1.2	.0	-.0	59.	59.
ACCEL SCALE FAC										
X	-430.	190.	-1.	.3	-.003	-1.2	.0	-.0	24.	24.
Y	-0.	-0.	-2.	-.0	.000	.0	-.0	-.0	0.	0.
Z	-135.	-757.	2.	-2.7	-.003	-1.3	-.0	-.0	73.	73.
ACCEL IA ALINE -TOWARD OA										
X	3.	-1.	0.	-.0	.000	.0	.0	.0	-0.	-0.
Y	-2.	2.	976.	.0	-.000	-.0	5.0	.0	-1.	-1.
Z	-179.	-432.	0.	-1.8	-.003	-1.3	.0	-.0	54.	54.
-TOWARD SA										
X	-1016.	173.	-3.	1.2	-.011	-5.1	-.0	-.0	40.	40.
Y	-1.	2.	721.	.0	.000	.0	1.8	.0	-1.	-1.
Z	1.	2.	0.	.0	.000	.0	.0	.0	-0.	-0.
PERFORMANCE										
RES ACT	-23.	-33631.	1.	.0	.000	.2	.0	1.8	-4035.	-4035.
S ISP	-2.	-5225.	1.	-.0	-.001	-.6	-.2	.6	-1245.	-1245.
S PROP	3.	-1294.	0.	-.0	-.000	-.1	-.0	.1	-333.	-333.
S INERT	1.	-1189.	1.	-.0	-.000	-.1	-.0	.1	-315.	-315.
O THRST	-24.	32756.	1.	.1	.001	.4	.1	3.6	-740.	-740.
O ISP	-6.	-9498.	0.	.2	-.004	-1.0	-.3	-.8	-1544.	-1544.
O INERT	1.	2734.	-0.	-.0	-.001	-.4	-.1	.4	93.	-1124.
ET INERT	1.	1272.	-0.	-.0	-.000	-.2	-.0	.2	95.	-333.
ET PROP	-5.	-10527.	1.	.0	.000	.1	.0	-2.1	-569.	-569.
AERODYNAMIC										
AX FR	-1.	-1646.	-0.	-.0	-.000	-.2	-.0	.2	-397.	-397.
B DRAG	-1.	-2006.	2.	-.0	-.000	-.2	-.1	.2	-453.	-453.
RSS =	1765.	49224.	4275.	5.9	.020	9.0	21.3	9.6	4657.	481[illegible]

TABLE V-B
COVARIANCE MATRIX
AT MECO

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	3.4623604+05						
V ACT	-1.5181052+05	2.6722301+06					
W ACT	-6.3509954+03	-1.8338533+03	2.0303323+06				
U-DOT ACT	1.8597271+03	-3.2268013+05	-3.1774387+01	3.9568239+02			
V-DOT ACT	-6.7292863+02	3.6551070+03	-1.6945515+01	-7.5260285+03	3.9849169+00		
W-DOT ACT	-3.0003975+01	5.7211308+02	7.9727250+03	-7.7530713-01	-8.8230006-02	5.0262551+01	
U NAV	-3.4643027+05	1.5303331+05	6.5039037+03	-1.8637779+03	6.7302185+02	3.1058491+01	3.4676175+05
V NAV	1.6553550+05	-2.8333307+05	5.5610743+03	1.1130735+03	-1.0801511+03	2.9114711+01	-1.8560837+05
W NAV	6.3486596+03	9.0910270+03	-2.0317819+06	2.3206932+01	1.7148874+01	-9.9803109+03	-6.5012272+03
U-DOT NAV	-1.9067279+03	1.0229990+03	3.0003677+01	-3.1197935+01	4.3711048+00	1.5071662-01	-1.9907170+03
V-DOT NAV	6.7081561+02	-1.0227790+03	1.1377989+01	4.1344945+00	-3.9645782+00	5.8493209-02	-6.7935046+02
W-DOT NAV	3.0202215+01	3.1564425+03	-1.0400082+04	1.6264240-01	9.2057589-02	-5.2500403+01	-3.1253384+01
WT	4.6680264+03	1.4722342+07	-9.7649521+02	-1.7535707+04	5.6934972+01	5.1600454+01	8.3582129+03

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT
V NAV	3.1216325+05					
W NAV	-5.6001363+03	2.0332332+06				
U-DOT NAV	-1.2043599+03	-2.9922222+01	1.1977153+01			
V-DOT NAV	1.0083116+03	-1.1522073+01	-4.4112298+00	4.0221196+00		
W-DOT NAV	-3.0477688+01	1.0436903+04	-1.4452184-01	-6.1422500-02	5.4866073+01	
WT	-1.2052834+04	1.4411165+03	3.0304337+01	4.5094460+01	1.6824810+00	2.4092267+06

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ORIGINAL PAGE I...

TABLE VI-A
LINEAR ERROR ANALYSIS
RSS DATA AT 506.6 SEC (NOMINAL MECO + 25 SEC)

	ALTITUDE FT	DOWN RANGE FT	CROSS RANGE FT	SPEED FPS	FLIGHT PATH ANGLE-DEG	ALTITUDE RATE-FPS	CROSS RANGE RATE-FPS	TIME SEC	WEIGHT LB	OMS PRO LB
PLATFORM ALINE										
AZIMUTH	-13.	-7.	4398.	-.0	-.000	-.1	19.8	.0	0.	0.
TILT	1241.	-1098.	4.	-4.1	.011	5.0	.0	.0	0.	0.
ROLL	8.	-0.	-1021.	-.0	.000	.0	-2.4	.0	0.	0.
DRIFT BIAS										
X	-0.	-1.	236.	.0	-.000	-.0	1.5	.0	0.	0.
Y	218.	-120.	0.	-.6	.003	1.3	.0	.0	0.	0.
Z	-0.	0.	-78.	-.0	.000	.0	-.2	.0	0.	0.
G-SENS IA DRIFT										
X	-1.	-1.	393.	-.0	-.000	-.0	2.1	.0	0.	0.
Y	-1.	1.	0.	.0	-.000	-.0	-.0	.0	0.	0.
Z	3.	-1.	-118.	-.0	.003	.0	-.3	.0	0.	0.
G-SENS SA DRIFT										
X	0.	0.	-1.	.0	.000	.0	-.0	.0	0.	0.
Y	423.	-206.	1.	-1.2	.006	2.9	.0	.0	0.	0.
Z	3.	-0.	-166.	-.0	.000	.0	-.5	.0	0.	0.
G-SENS OA DRIFT										
X	-0.	-1.	453.	-.0	.000	.0	3.1	.0	0.	0.
Y	356.	-229.	2.	-1.0	.004	1.8	.0	.0	0.	0.
Z	-0.	0.	0.	.0	.000	.0	.0	.0	0.	0.
G-SENS-SQ DRIFT										
X	-0.	0.	-0.	.0	.000	.0	-.0	.0	0.	0.
Y	-2.	1.	0.	.0	-.000	-.0	-.0	.0	0.	0.
Z	2.	-0.	-141.	-.0	.000	.0	-.4	.0	0.	0.
ACCEL BIAS										
X	-629.	483.	-1.	.6	-.003	-2.3	-.0	.0	0.	0.
Y	-4.	-2.	599.	.0	.000	.0	2.1	.0	0.	0.
Z	-160.	55.	0.	-2.1	-.003	-1.2	.0	.0	0.	0.
ACCEL SCALE FAC										
X	-457.	431.	-0.	.3	-.003	-1.2	.0	.0	0.	0.
Y	0.	0.	-2.	.0	.000	.0	-.0	.0	0.	0.
Z	-162.	11.	1.	-2.7	-.003	-1.4	-.0	.0	0.	0.
ACCEL IA ALINE										
-TOWARD OA										
X	4.	-2.	0.	-.0	.000	.0	.0	.0	0.	0.
Y	-2.	-5.	1077.	.0	-.000	-.0	4.9	.0	0.	0.
Z	-230.	143.	0.	-1.7	-.003	-1.4	.0	.0	0.	0.
-TOWARD SA										
X	-1190.	717.	-3.	1.4	-.011	-5.1	-.0	.0	0.	0.
Y	-1.	-6.	766.	.0	.000	.0	1.8	.0	0.	0.
Z	1.	-0.	0.	.0	.000	.0	.0	.0	0.	0.
PERFORMANCE										
WEB ACT	-521.	-76555.	0.	.5	.001	.2	.1	.0	0.	0.
S ISP	-144.	-17353.	-3.	.1	-.001	-.6	-.1	.0	0.	0.
S PROP	-33.	-5567.	-1.	.0	-.000	-.1	-.0	.0	0.	0.
S INERT	-33.	-4765.	0.	.0	-.000	-.1	-.0	.0	0.	0.
O THRST	-833.	-58310.	4.	1.0	.002	.4	.2	.0	0.	0.
O ISP	122.	10667.	-9.	.0	-.004	-1.6	-.4	.0	0.	0.
O INERT	-93.	-6321.	-3.	.1	-.001	-.4	-.1	.0	0.	0.
ET INERT	-37.	-3031.	-1.	.0	-.000	-.2	-.0	.0	1215.	0.
ET PROP	432.	38506.	1.	-.5	-.000	.1	-.1	.0	0.	0.
AERODYNAMIC										
AX FR	-44.	-6152.	-1.	.0	-.000	-.2	-.0	.0	0.	0.
B DRAG	-50.	-7139.	0.	.0	-.000	-.2	-.0	.0	0.	0.
RSS =	2259.	106882.	4798.	6.2	.020	8.9	21.1	.0	1215.	.0

TABLE VI-B

COVARIANCE MATRIX

AT NOMINAL MECO + 25 SEC

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	5.6723795+03						
V ACT	1.2321598+07	1.2693028+09					
W ACT	-8.9422389+03	-3.2695080+09	2.5581717+00				
U-DOT ACT	-1.2754098+04	-1.5410341+06	2.8909492+00	1.8795926+03			
V-DOT ACT	-8.1581631+02	2.1132035+03	-1.6001723+01	-5.9832887+00	4.1035651+00		
W-DOT ACT	-6.6795833+01	-2.7911776+03	1.1135349+01	3.3053769+00	-8.2566562-02	4.9492008+01	
U NAV	-4.3049527+05	3.2307304+05	8.1400030+03	-2.2017633+03	8.0746708+02	3.5170074+01	4.4045913+05
V NAV	2.3753914+05	-2.3375245+05	6.4110377+03	1.0844733+03	-1.2310184+03	2.9201324+01	-2.3767255+05
W NAV	8.0413333+03	1.6569416+04	-2.5720325+00	1.7430500+01	1.8045302+01	-1.1169428+04	-8.1210510+03
U-DOT NAV	-2.2473513+03	1.6509421+03	3.4177958+01	-1.1030435+01	4.9223527+00	1.5024621-01	2.2671880+03
V-DOT NAV	8.1242811+02	-6.8237671+02	1.1600736+01	3.7011525+00	-4.2010376+00	5.3156220-02	-8.1354065+02
W-DOT NAV	3.3845663+01	3.0148307+01	-1.1627104+04	1.3296200-01	8.6599147-02	-5.1733532+01	-3.5059645+01
WT	-1.1418790+04	-8.5338724+05	-3.5854064+02	9.8616433+02	1.0882241+00	-1.1823731+01	-2.5878216+02

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT
V NAV	3.8298533+05					
W NAV	-6.6155625+03	2.5803025+06				
U-DOT NAV	-1.3622603+03	-3.3865523+01	1.2385921+01			
V-DOT NAV	1.2169977+03	-1.2473406+01	-4.6568155+00	4.2656952+00		
W-DOT NAV	-3.0329238+01	1.1694509+04	-1.4976739-01	-5.6796127-02	5.4113456+01	
WT	5.4764403+01	9.2071561+00	-5.7662358-02	2.8779299-01	-6.2940345-02	1.6402447+05

REPRODUCIBILITY OF THE ORIGINAL PAGE IS POOR

TABLE VII-A
LINEAR ERROR ANALYSIS

RSS DATA AT INSERTION (EVENT)

	ALTITUDE FT	DOWN RANGE FT	CROSS RANGE FT	SPEED FPS	FLIGHT PATH ANGLE-DEG	ALTITUDE RATE-FPS	CROSS RANGE RATE-FPS	TIME SEC	WEIGHT LB	OMS PROP LB
PLATFORM ALINE										
AZIMUTH	-24.	403.	7320.	-.0	-.000	-.1	16.1	.0	-1.	-1.
TILT	1879.	-1852.	5.	-4.8	.008	4.4	.0	.0	-1.	-1.
ROLL	13.	57.	-1375.	-.0	.000	.0	-2.1	.0	-0.	-3.
DRIFT BIAS										
X	-3.	-87.	455.	.0	-.000	-.0	1.4	-.0	0.	-0.
Y	405.	-6.	1.	-.8	.002	1.3	.0	.0	-0.	-0.
Z	1.	67.	-111.	.0	.000	.0	-.2	.0	-0.	-0.
G-SENS IA DRIFT										
X	-3.	-27.	704.	-.0	-.000	-.0	1.9	-.0	0.	0.
Y	-3.	-64.	0.	.0	-.000	-.0	-.0	-.0	0.	0.
Z	9.	157.	-169.	-.0	.000	.0	-.3	.0	-0.	-0.
G-SENS SA DRIFT										
X	5.	64.	-2.	-.0	.000	.0	-.0	.0	-0.	-0.
Y	833.	-31.	2.	-1.6	.005	2.7	.0	.0	-1.	-1.
Z	8.	128.	-233.	-.0	.000	.0	-.4	.0	-0.	-0.
G-SENS OA DRIFT										
X	3.	56.	916.	-.0	.000	.0	2.9	.0	-0.	-0.
Y	603.	-363.	2.	-1.3	.003	1.7	.0	.0	-0.	-0.
Z	2.	45.	1.	-.0	.000	.0	.0	.0	-0.	-0.
G-SENS-SW DRIFT										
X	1.	66.	-2.	.0	.000	.0	-.0	.0	-0.	-0.
Y	-4.	98.	0.	.0	-.000	-.0	-.0	.0	-0.	-0.
Z	11.	-55.	-203.	-.0	.000	.1	-.4	-.0	0.	0.
ACCEL BIAS										
X	-943.	3109.	-2.	1.1	-.005	-2.2	-.0	.1	-4.	-4.
Y	0.	318.	914.	.0	.000	.0	1.9	.0	-0.	-0.
Z	-570.	-15481.	2.	-2.5	-.005	-1.5	.0	-.6	27.	22.
ACCEL SCALE FAC										
X	-639.	144.	1.	.5	-.003	-1.2	.0	-.0	0.	0.
Y	7.	100.	-3.	-.0	.003	.0	-.0	.0	-0.	-0.
Z	-488.	-2489.	-1.	-2.4	-.003	-1.7	-.0	-.1	2.	2.
ACCEL IA ALINE										
-TOWARD OA										
X	11.	173.	1.	-.0	.000	.0	.0	.0	-0.	-0.
Y	-1.	105.	1829.	.0	.000	.0	4.5	.0	-0.	-0.
Z	-484.	-207.	0.	-1.4	-.003	-1.6	-.0	-.0	-1.	-1.
-TOWARD SA										
X	-1892.	1113.	-4.	2.3	-.010	-5.0	-.0	-.0	-0.	-0.
Y	1.	-22.	1029.	-.0	.000	.0	1.6	-.0	0.	0.
Z	3.	-105.	0.	-.0	.000	.0	.0	-.0	0.	0.
PERFORMANCE										
AEB ALT	-22.	-32086.	-1.	-.0	.000	.0	.0	1.7	2.	2.
S ISP	-119.	-3897.	-31.	.3	-.002	-.8	-.2	.6	-2.	-2.
S PROP	-23.	-696.	-8.	.1	-.000	-.2	-.0	.2	-1.	-1.
S INERT	-24.	-753.	-6.	.1	-.000	-.2	-.0	.2	-1.	-1.
O THRST	31.	29762.	29.	-.1	.001	.4	.1	3.4	5.	5.
O ISP	-309.	-10078.	-64.	.6	-.007	-1.7	-.3	-.8	1.	1.
O INERT	74.	21170.	-20.	.0	-.001	-.5	-.1	1.1	1188.	-27.
ET INERT	-27.	2002.	-7.	.1	-.000	-.2	-.0	.2	-1.	-1.
ET PROP	14.	-17247.	0.	-.0	.000	.2	.0	-2.2	1.	1.
AERODYNAMIC										
AX FR	-29.	-935.	-8.	.1	-.000	-.2	-.0	.2	-1.	-1.
B DRAG	-36.	-1216.	-10.	.1	-.001	-.2	-.1	.2	-1.	-1.
RSS =	3248.	55195.	7899.	7.0	.018	8.6	19.3	9.7	1188.	36.

TABLE VII-B

COVARIANCE MATRIX

AT INSERTION

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	1.1721526+06						
V ACT	6.6567062+05	3.3850432+08					
W ACT	-1.7394728+04	4.9770532+05	6.9328374+06				
U-DOT ACT	1.7565800+03	-4.0304063+03	-3.5069164+02	4.9207138+02			
V-DOT ACT	-1.5916095+03	9.3571924+03	-8.7784610+03	-1.3919306+01	5.6722099+00		
W-DOT ACT	-3.5533069+01	1.1672063+03	1.6696746+04	-1.4616176+00	-4.5015730-02	4.1526798+01	
U NAV	-1.1986802+06	9.4230904+04	2.3997454+04	-2.9321395+03	1.0042423+03	5.9380204+01	1.2425362+06
V NAV	7.1693235+05	-2.6038300+06	1.0391607+04	4.2057264+03	-2.4603643+03	2.6767403+01	-7.6207147+05
W NAV	1.9575630+04	-3.6645181+05	-7.1337370+06	5.1090676+02	5.4912603+00	-1.7397045+04	-2.3677287+04
U-DOT NAV	-3.9497385+03	4.6717543+02	5.7783072+01	-9.7603867+00	5.9068293+00	1.4515513-01	4.0944187+03
V-DOT NAV	1.6665385+03	-6.9174899+03	4.8809526+00	1.1117770+01	-5.7404839+00	1.7675832-02	-1.8039422+03
W-DOT NAV	4.6037100+01	-9.7058512+02	-1.0220433+04	1.3649207+00	1.8369075-02	-4.4010841+01	-5.7703095+01
WT	8.6530194+03	2.7595860+06	-3.1021024+03	-3.4016700+03	2.3376001+01	-1.9804304+01	5.7739877+02

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT
V NAV	1.1310191+06					
W NAV	-1.0866280+04	7.3123486+06				
U-DOT NAV	-2.6677273+03	-5.6440779+01	1.3649502+01			
V-DOT NAV	2.5974600+03	-6.0504300+00	-6.3131600+00	5.9054679+00		
W-DOT NAV	-3.0110552+01	1.8772602+04	-1.3660392-01	-1.6837233-02	4.8461839+01	
WT	-2.4900322+03	6.8374608+02	2.8351011+00	6.8400862+00	1.3651472+00	1.5675110+05

TABLE VIII-A

LINEAR ERROR ANALYSIS

RSS DATA AT 666.2 SEC (NOMINAL INSERTION + 25 SEC)

	ALTITUDE FT	DOWN RANGE FT	CROSS RANGE FT	SPEED FPS	FLIGHT PATH ANGLE-DEG	ALTITUDE RATE-FPS	CROSS RANGE RATE-FPS	TIME SEC	WEIGHT LB	OMS PROP LB
PLATFORM ALINE										
AZIMUTH	-30.	-9.	7767.	.0	-.000	-.1	17.8	.0	-1.	-1.
TILT	1956.	-2278.	6.	-4.9	.007	3.4	.0	.0	-1.	-1.
ROLL	13.	-4.	-1428.	-.0	.000	.0	-2.1	.0	-0.	-0.
DRIFT BIAS										
X	-3.	-0.	469.	-.0	-.000	-.0	1.4	.0	0.	0.
Y	429.	-325.	1.	-.8	.002	1.1	.0	.0	-0.	-0.
Z	0.	0.	-116.	.0	.000	.0	-.2	.0	-0.	-0.
G-SENS IA DRIFT										
X	-3.	-1.	751.	-.0	-.000	-.0	1.9	.0	0.	0.
Y	-2.	2.	0.	.0	-.000	-.0	-.0	.0	0.	0.
Z	9.	-4.	-176.	-.0	.000	.0	-.3	.0	-0.	-0.
G-SENS SA DRIFT										
X	5.	-2.	-3.	-.0	.000	.0	-.0	.0	-0.	-0.
Y	887.	-609.	3.	-1.7	.005	2.4	.0	.0	-1.	-1.
Z	8.	-3.	-249.	-.0	.000	.0	-.4	.0	-0.	-0.
G-SENS OA DRIFT										
X	3.	-3.	988.	-.0	.000	.0	2.9	.0	-0.	-0.
Y	636.	-550.	3.	-1.3	.003	1.4	.0	.0	-0.	-0.
Z	2.	-1.	1.	-.0	.000	.0	.0	.0	-0.	-0.
G-SENS-SQ DRIFT										
X	0.	0.	-2.	.0	.000	.0	-.0	.0	-0.	-0.
Y	-5.	3.	0.	.0	-.000	-.0	-.0	.0	-0.	-0.
Z	12.	-5.	-212.	-.0	.000	.1	-.4	.0	0.	0.
ACCEL BIAS										
X	-1017.	822.	-3.	1.2	-.005	-2.1	-.0	.0	-4.	-4.
Y	-3.	-1.	962.	.0	.000	.0	1.9	.0	-0.	-0.
Z	-477.	-235.	3.	-2.6	-.005	-2.3	.0	.0	22.	22.
ACCEL SCALE FAC										
X	-663.	633.	1.	.5	-.002	-1.1	.0	.0	0.	0.
Y	8.	-3.	-3.	-.0	.000	.0	-.0	.0	-0.	-0.
Z	-531.	-358.	-1.	-2.3	-.006	-2.5	-.0	.0	2.	2.
ACCEL IA ALINE -TOWARD OA										
X	11.	-6.	1.	-.0	.000	.0	.0	.0	-0.	-0.
Y	-2.	-5.	1941.	.0	.000	.0	4.5	.0	-0.	-0.
Z	-533.	-46.	0.	-1.5	-.005	-2.1	-.0	.0	-1.	-1.
-TOWARD SA										
X	-2005.	1412.	-4.	2.4	-.010	-4	-.0	.0	-0.	-0.
Y	1.	-7.	1066.	-.0	.000	.0	1.6	.0	0.	0.
Z	4.	-1.	1.	-.0	.000	.0	.0	.0	0.	0.
PERFORMANCE										
WEB ACT	-565.	-76894.	-1.	.5	-.001	.0	.1	.0	2.	2.
S ISP	-294.	-19406.	-35.	.4	-.002	-.7	-.2	.0	-2.	-2.
S PROP	-70.	-50066.	-9.	.1	-.001	-.2	-.0	.0	-1.	-1.
S INERT	-67.	-49763.	-7.	.1	-.000	-.2	-.0	.0	-1.	-1.
C THRST	-669.	-58851.	33.	.0	-.001	.4	.2	.0	5.	5.
O ISP	-153.	16905.	-73.	.4	-.003	-1.6	-.4	.0	1.	1.
O INERT	-191.	-6418.	-22.	.3	-.002	-.4	-.1	.0	1188.	-27.
ET INERT	-80.	-3317.	-8.	.1	-.001	-.2	-.0	.0	-1.	-1.
ET PROP	529.	36813.	0.	-.7	.002	.1	-.1	.0	1.	1.
AERODYNAMIC										
AX FR	-85.	-6175.	-9.	.1	-.001	-.2	-.0	.0	-1.	-1.
B DRAG	-100.	-7169.	-12.	.2	-.001	-.2	-.1	.0	-1.	-1.
RSS =	3610.	107591.	8375.	7.3	.016	8.2	19.0	.0	1188.	36.

TABLE VIII-B

COVARIANCE MATRIX

AT NOMINAL INSERTION + 25 SEC

	U ACT	V ACT	W ACT	U-DOT ACT	V-DOT ACT	W-DOT ACT	U NAV
U ACT	1.4489110+06						
V ACT	1.2589866+07	1.2862053+09					
W ACT	-2.6605238+04	-1.8305628+05	7.7931569+06				
U-DOT ACT	-1.2210385+04	-1.5452401+06	1.6391277+02	1.6637174+03			
V-DOT ACT	-1.7800040+03	5.1208659+03	-8.9404981+00	-8.7975020+00	5.8410615+00		
W-DOT ACT	-7.7607085+01	-2.6572712+03	1.7650166+04	3.1075047+03	-3.9732001-02	9.0285895+01	
U NAV	-1.3394275+06	1.0733976+06	2.7005761+04	-4.2393721+03	1.8434650+03	6.0611500+01	1.9046617+06
V NAV	8.4520122+05	-1.0505947+06	1.0418202+04	2.4358287+03	-2.7136160+03	2.3345017+01	-8.8230619+05
W NAV	2.6314537+04	1.0211507+04	-6.0113043+06	6.1200737+01	4.2557369+00	-1.8222031+04	-2.6598640+04
U-DOT NAV	-4.1770043+03	3.4592612+03	6.2149016+01	-1.3271800+01	6.1356513+00	1.4024131-01	4.4079829+03
V-DOT NAV	1.8766708+03	-2.2754734+03	4.0995376+00	5.4662452+00	-5.9526165+00	6.3617913-03	-1.9826299+03
W-DOT NAV	5.8935373+01	3.5400772+01	-1.9057992+04	1.2300369-01	1.4548711-02	-4.3518596+01	-6.0297488+01
WT	-2.6505737+04	-8.8252782+05	-3.4780546+03	9.6490800+02	2.6469665+01	-1.4432772+01	7.0976779+02

	V NAV	W NAV	U-DOT NAV	V-DOT NAV	W-DOT NAV	WT
V NAV	1.3143407+06					
W NAV	-1.1341308+04	6.3000139+06				
U-DOT NAV	-2.9559337+03	-6.0403456+01	1.3980838+01			
V-DOT NAV	-2.8102273+03	-5.4032375+00	-6.5676768+00	6.1779872+00		
W-DOT NAV	-2.9352362+01	1.9693330+04	-1.3561390-01	-1.6355036-02	4.7145636+01	
WT	2.6738886+03	7.2139639+02	3.2106999+00	7.0129426+00	1.3492843+00	1.5675110+05

TABLE IX

Exchange Ratio At Nominal MECO

Parameter Varied	Δ ET Propellant / Δ Parameter
Web Action Time (constant ISP)	-857. lb/%
SRB Vacuum ISP (constant $\dot{W}$)	2490. lb/%
SRB Propellant Loading	1586. lb/%
SRB Inert Weight	-.11 lb/lb
Orbiter Thrust (constant ISP)	.07 lb/lb *
Orbiter ISP (constant $\dot{W}$)	1163. lb/sec **
Orbiter Inert Weight	-.92 lb/lb
External Tank Inert Weight	-.92 lb/lb
External Tank Propellant Loading	.08 lb/lb

* Trade factor based on total system thrust variation (LB/3 ENG).
** Trade factor based on total system ISP variation (SEC/3 ENG).

TABLE X

RSS SUMMARY DATA (ACTUAL PERTURBED STATE - NOMINAL STATE)

	ALTITUDE FT	DOWN RANGE FT	CROSS RANGE FT	SPEED FPS	FLIGHT PATH ANGLE-DEG	ALTITUDE RATE-FPS	CROSS RANGE RATE-FPS	TIME SEC	WEIGHT LB	SSME PROP LB	OMS PROP LB
SRB SEPARATION	2201.	12422.	212.	55.9	.445	46.7	4.1	5.6	20614.	20354.	-
MECO	1765.	49224.	4275.	5.9	.020	9.0	21.3	4.6	4657.	4918.	-
NOMINAL MECO +25 SEC	2259.	106882.	4798.	6.2	.020	8.9	21.1	.0	1215.	-	0.
INSERTION	3248.	55195.	7899.	7.0	.018	8.6	19.3	4.7	1188.	-	36.
NOMINAL INSERTION +25 SEC	3610.	107591.	8375.	7.3	.018	8.2	19.0	.0	1188.	-	36.

NOTE: These dispersions are indicative of 3σ evaluations of the simulated uncertainties.

TABLE XI

RSS SUMMARY DATA (PERTURBED NAVIGATED STATE - ACTUAL PERTURBED STATE)

	ALTITUDE FT	DOWN RANGE FT	CROSS RANGE FT	SPEED FPS	FLIGHT PATH ANGLE-DEG	ALTITUDE RATE-FPS	CROSS RANGE RATE-FPS	TIME SEC	WEIGHT LB	SSME PROP LB	OMS PROP LB
SRB SEPARATION	80.	139.	196.	1.9	.021	1.8	4.4	5.6	20614.	20354.	-
MECO	1767.	1676.	4278.	6.0	.021	9.3	22.2	4.6	4657.	4818.	-
NOMINAL MECO +25 SEC	1991.	1857.	4824.	6.1	.021	9.3	22.1	.0	1215.	-	0.
INSERTION	3344.	3190.	8129.	7.2	.020	9.4	20.9	4.7	1188.	-	36.
NOMINAL INSERTION +25 SEC	3555.	3439.	8643.	7.4	.020	9.1	20.6	.0	1188.	-	36.

NOTE: These dispersions are indicative of 3σ evaluations of the simulated uncertainties.

TABLE XII

Principal Error Contributors To Covariance Matrix at MECO

State Vector Component *	Principal Error Sources
u	Platform misalignment (tilt), and accelerometer input axis misalignment toward spin axis (X).
v	Web action time, orbiter thrust and external tank propellant loading.
w	Platform misalignment (azimuth and roll) and accelerometer input axis misalignment toward output axis (Y).
$\dot{u}$	Web action time, orbiter thrust, platform misalignment (tilt) and accelerometer input axis misalignment toward spin axis (X).
$\dot{v}$	Platform misalignment (tilt), accelerometer bias (Z), accelerometer scale factor (Z) and accelerometer input axis misalignment toward output axis (Z).
$\dot{w}$	Platform misalignment (azimuth).

* Both the actual and navigated state vectors.