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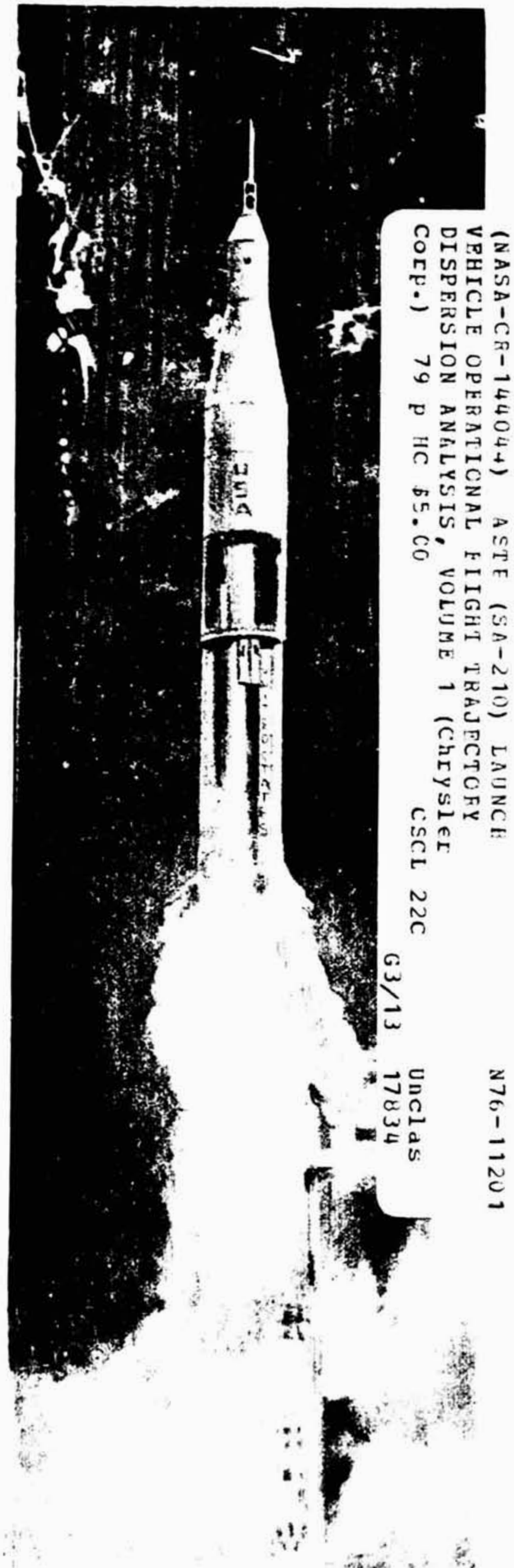

Contract NAS8-4016
Apollo/Soyuz Test Project

DRL 444-V4a

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS

VOLUME I

APRIL 4, 1975

SPACE DIVISION CHRYSLER CORPORATION

TECHNICAL NOTE **TN-FT-75-42**

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APOLLO/SOYUZ TEST PROJECT

by

FLIGHT TECHNOLOGY BRANCH

CHRYSLER CORPORATION SPACE DIVISION

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FOREWORD

This document is Data Requirements List (DRL) Item 444-V4a. It is Volume I of the two volume documentation required for the ASTP (SA-210) Launch Vehicle Operational Flight Trajectory Dispersion Analysis under Contract NAS 8-4016, Schedule II, Modification MSFC-1, Amendment 199. The associated Guidance Hardware Error Analysis is documented separately, as Volume II, because it contains classified material.

Acknowledgements are made to the personnel of Marshall Space Flight Center SA&I-EL24 for their assistance and cooperation.

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DEFINITIONS AND SYMBOLS

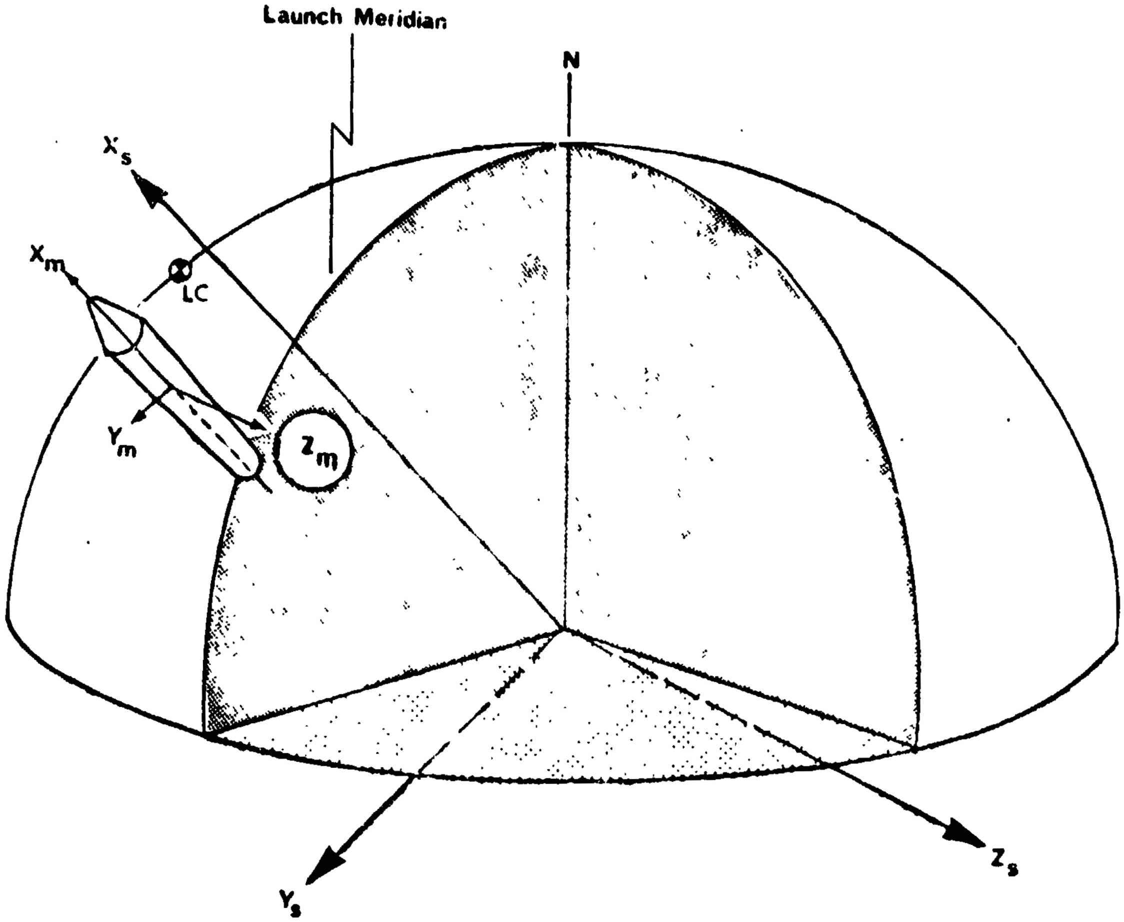
Aerodynamic Heating Indicator	$\int \frac{q V_r}{\pi/2 - \lvert\alpha_t\rvert} dt$ q = dynamic pressure, V_r = relative velocity, α_t = total angle of attack
Aerodynamic Load Indicator	Product of dynamic pressure and angle of attack.
Altitude	Vehicle altitude above the reference ellipsoid measured along the geocentric position vector.
Angle of Attack, Pitch	Angle between the pitch plane component of the relative velocity vector and the longitudinal axis of the vehicle, measured positive nose up.
Apogee Altitude	Apogee height of the osculating conic above the reference ellipsoid, referenced to the equatorial radius, 6378165 meters.
Attitude Command	Eulerian angle command, derived by the guidance system and transmitted to the control system.
Attitude Error	Difference between the vehicle attitude (pitch, yaw and roll Eulerian angles) and the vehicle attitude command.
Axial Force	Component of the resultant aerodynamic force along the vehicle longitudinal axis (X axis of PASCS 8a), measured positive toward the nose of the vehicle.
Descending Node Argument	Angle measured in the equatorial plane between the orbit descending node and the space fixed launch meridian defined at Guidance Reference Release.
Drag	Component of the resultant aerodynamic force along the relative velocity vector. measured positive opposite to the velocit vector.
Dynamic Pressure	$\frac{1}{2}$ x (Density) x (Relative Velocity)^2

DEFINITIONS AND SYMBOLS (CONT'D)

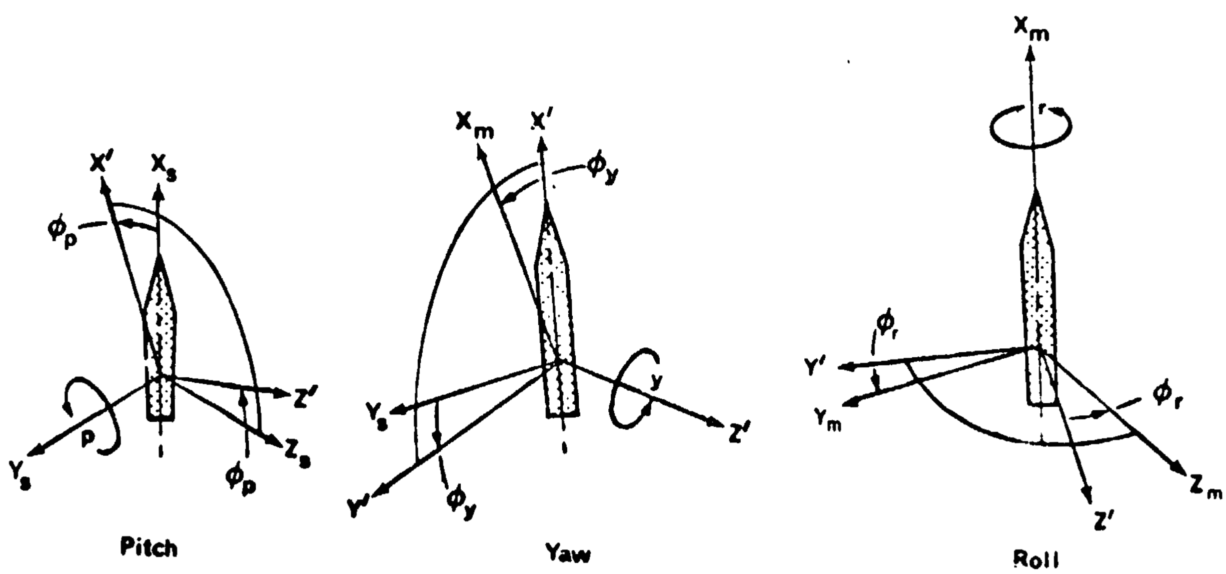
Earth Fixed Cross Range	Ye component of PASCS 10 position vector.
Earth Fixed Flight Path Angle	Angle between the earth fixed velocity vector and the earth fixed geocentric position vector (PASCS 11), measured positive downrange from the position vector.
Earth Fixed Position	Position vector/components in an earth-fixed pad-centered plumbline coordinate system. The Xe axis is coincident with the reference ellipsoid normal, positive upward. The Ze axis is parallel to the earth-fixed aiming azimuth and is positive downrange. The Ye axis completes a right handed system. (PASCS 10)
Earth Fixed Velocity	Velocity vector/components in PASCS 10.
Earth Fixed Velocity Magnitude	$\sqrt{\dot{X}e^2 + \dot{Y}e^2 + \dot{Z}e^2}$
Eccentricity	Eccentricity of the osculating conic.
Flight Azimuth	Angle defining orientation of the space fixed coordinate system downrange axis, Zs, at Guidance Reference Release, measured positive east of north in plane normal to the space fixed Xs axis.
Geocentric Declination	Angle between the geocentric radius vector and the true equatorial plane, measured positive north of the equator.
Geodetic Latitude	Angle between the reference ellipsoid normal through the point of interest and the true equatorial plane, measured positive north of the equator.
Ground Range	Surface distance from launch site to the sub-vehicle point, positive east (0° - 180°).
Inclination	Angle between the instantaneous flight plane and the equatorial plane.
Inertial Range Angle	Angle between the instantaneous space fixed position vector and the space fixed position vector at Guidance Reference Release.

DEFINITIONS AND SYMBOLS (CONT'D)

Longitude	Angle between the Greenwich meridian plane and the projection of the geocentric position vector in the equatorial plane, measured positive east of Greenwich.
Longitudinal Acceleration	That part of the total measurable acceleration directed along the longitudinal axis of the vehicle.
Mach Number	(Relative Velocity) ÷ (Local Speed of Sound)
Mass	Mass of the vehicle.
Navigation Coordinate System	This system is identical to PASCS 13 with ideal navigation.
Normal Force	Magnitude of the resultant aerodynamic force normal to the vehicle longitudinal axis, and in the plane defined by that axis and the relative velocity vector.
Perigee Altitude	Perigee height of the osculating conic above the reference ellipsoid, referenced to the equatorial radius, 6378165 meters.
Period	Period of the osculating conic.
Pitch, Yaw, Roll (Inertial)	Eulerian angles of vehicle attitude measured with respect to the space fixed coordinate system. Vehicle attitude is defined by the ordered rotation of pitch, yaw, and roll. (See illustration)
Radius	Space fixed position vector magnitude, $\sqrt{XS^2 + YS^2 + ZS^2}$.
Range	Surface distance from launch site to the sub-vehicle point, positive east (0° - 180°).
Relative Vehicle Attitude	Pitch, yaw and roll angles of the vehicle in an earth relative system. The roll axis is the projection of the velocity vector in the local horizontal plane; the yaw axis is in the local vertical plane, positive toward the center of the earth; the pitch axis completes a right handed system. Vehicle attitude is defined by ordered rotation-pitch, yaw and roll.



$$\bar{X}_m = (\phi_r)_1 (\phi_y)_3 (\phi_p)_2 \bar{X}_s$$



DEFINITIONS AND SYMBOLS (CONT'D)

Relative Velocity	Velocity relative to the atmosphere (includes wind velocity).
Semi-Major Axis	Length of the chord in the orbit plane connecting the apogee and the perigee of the osculating conic.
Space Fixed Cross Range	Ys component of PASCS 13 position vector.
Space Fixed Flight Path Angle	Angle between the space fixed velocity vector and the radius vector (PASCS 13), measured positive downrange from radius vector.
Space Fixed Position	Position vector/components in a space fixed earth centered, plumbline coordinate system defined at Guidance Reference Release. The Xs axis is parallel to the reference ellipsoid normal which passes through the launch site. The Zs axis is parallel to, and positive in the same direction as, the earth-fixed firing azimuth. The Ys axis completes the right handed system. This is Project Apollo Standard Coordinate System 13. (PASCS 13).
Space Fixed Velocity	Velocity vector/components in PASCS 13.
Space Fixed Velocity Magnitude	$\sqrt{\dot{X}s^2 + \dot{Y}s^2 + \dot{Z}s^2}$
Time	Instantaneous flight time referenced to first motion.
Three Sigma (3σ)	Three standard deviations.
Thrust	Total effective thrust magnitude, $\sqrt{FTX^2 + FTY^2 + FTZ^2}$.
True Anomaly	Angular displacement of the vehicle C.G. from the perigee, measured in the direction of the motion.
Velocity Vector Azimuth	The angle between the velocity vector projection on the earth's surface and true north.

DEFINITIONS AND SYMBOLS (CONT'D)

Vehicle Weight	Instantaneous total vehicle weight.
X_4 Position Vector	Vehicle c.g. displacement components in a space fixed, right handed, target coordinate system with its origin at the center of the earth. The X_4 axis passes through the descending node of the orbit plane. The Z_4 axis lies in the desired orbit plane 90° downrange from the X_4 axis. The Y_4 axis completes a right handed system and is perpendicular to the orbit plane.

DEFINITION AND SYMBOLS (CONT'D)

AFETR	Air Force Eastern Test Range
AFB	Air Force Base
AHI	Aerodynamic Heating Indicator
APS	Auxiliary Propulsion System
APSO	Apollo Soyuz Program Office
AS	Apollo Saturn
ASTP	Apollo Soyuz Test Project
B-7	Trajectory Data Tape
C	C-Band Radar Stations
C/O	Cutoff
CS	Command System
CCSD	Chrysler Corporation Space Division
C.G.	Center of Gravity
CM	Command Module
CSM	Command and Service Modules
DELTA (Δ)	Increment
(ΔP)	Parameter Increment
DIA	Vehicle Diameter
DM	Docking Module
DRL	Data Requirements List
ECF	End Conditions of Flight
EMR	Engine Mixture Ratio
F	Average Longitudinal Sea Level Thrust
FPR	Flight Performance Reserve
FT	Flight Technology
g	Acceleration of Gravity at Sea Level (9.80665 m/sec^2)

DEFINITIONS AND SYMBOLS (CONT'D)

GCS	Guidance Cutoff Signal
GET	Ground Elapsed Time
GFD	Government Furnished Documentation
GH_2	Gaseous Hydrogen
GMT	Greenwich Mean Time
GRR	Guidance Reference Release
GSFC	Goddard Space Flight Center
H-1	S-IB Stage Engine
i	Inclination
IBM	International Business Machines Corp.
IECO	Inboard Engine Cutoff Signal
IGM	Iterative Guidance Mode
IMU	Inertial Measurement Unit
ISP	Specific Impulse
IU	Instrument Unit
J-2	S-IVB Stage Engine
KSC	Kennedy Spaceflight Center
LAC	Loss of Attitude Control
LC	Launch Complex
LES	Launch Escape System
LH_2	Liquid Hydrogen
LMSC/HREC	Lockheed Missiles and Space Company/Huntsville Research and Engineering Center
LOX	Liquid Oxygen
LSA	Level Sensor Actuation
LVDC	Launch Vehicle Digital Computer

DEFINITIONS AND SYMBOLS (CONT'D)

L/V	Launch Vehicle
LWC	Launch Window Closing
LWO	Launch Window Opening
MDAC	McDonnell Douglas Aircraft Corporation
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
N_2	Liquid Nitrogen
N/A	Not Applicable
N/D	Non-Dimensional
NPV	Non-Propulsive Vent
OECO	Outboard Engine Cutoff Signal
OI	Orbit Insertion
OT	Operational Trajectory
PASCS	Project Apollo Standard Coordinate System
POT	Preliminary Operational Flight Trajectory
PSF; psf	Pounds Per Square Foot
q	Dynamic Pressure
RP-1	S-IB Propellant
RSS	Root-Sum-Square
S-IB	First Stage of the Saturn IB Launch Vehicle
S-IU	Saturn Launch Vehicle Instrument Vehicle
S-IVB	Second Stage of the Saturn IB Launch Vehicle
SA	Saturn
SC	Spacecraft

DEFINITIONS AND SYMBOLS (CONT'D)

SIGMA (σ)	Standard Deviation
(Σ)	Summation of
SLA	Spacecraft Launch Adapter
SM	Service Module
STA	Vehicle Station Location
T	Telemetry Stations; Time Base One Time
TO	Time Base Zero
T1	Time Base One
T2	Time Base Two
T3	Time Base Three
T4	Time Base Four
TN	Technical Note
UHF	Ultra High Frequency
USA	United States of America
USSR	Union of Soviet Socialist Republics
VHF	Very High Frequency
$\dot{W}$	Flowrate

SUMMARY

This report presents the ASTP (SA-210) Launch Vehicle Operational Flight Trajectory (OT) three sigma (3 σ) flight parameter envelopes, the S-IVB Stage Flight Performance Reserve (FPR), the S-IB stage design parameter envelopes, and pertinent trade-off factors. The ASTP (SA-210) Launch Vehicle 500 Pound Launch Window Opening Operational Flight Trajectory was utilized as the nominal for this analysis.

The flight envelopes presented are the results of statistical combinations of perturbation effects, employing the Root-Sum-Square (RSS) technique. Concise summaries of pertinent trajectory parameter dispersions at S-IB/S-IVB Separation and Orbit Insertion (OI) follow.

	S-IB/S-IVB Sep.		Orbit Insertion	
	+RSS	-RSS	+RSS	-RSS
Flight Time (sec)	2.82	2.65	10.99	10.46
Radius (m)	2050.	2303.	505.	502.
Space Fixed Velocity (m/sec)	46.10	41.82	2.47	2.46
Space Fixed Path Angle (deg)	1.872	1.776	0.018	0.018
Ground Range (m)	4646.	3607.	40192.	38336.
Earth Fixed Cross Range (m)	4002.	2377.	4928.	5125.
Inclination (deg)	-----	-----	0.019	0.019
Descending Node Argument (deg)	-----	-----	0.019	0.019

Three sigma (3σ) variations in the establishments of the Launch Vehicle Digital Computer (LVDC) time bases T2, T3, and T4 are displayed in the following table. Also included are the 3σ variations in the time that dynamic pressure (q) decreases to one pound per square foot (psf). The time bases initiate independent event sequences and $q \leq 1$ psf is a primary Launch Escape System (LES) jettisoning criterion.

	T2 (sec)	T3 (sec)	T4 (sec)	T3 Time of q = 1 psf (sec)
RSS (+)	2.70	2.82	10.99	5.37
RSS (-)	2.53	2.65	10.46	4.83

The 3σ deviations in J-2 engine ignition and Engine Mixture Ratio (EMR) shift times are the same as those shown for T3, since they are programmed T3 events.

The S-IVB stage three sigma Flight Performance Reserve (FPR) requirements for this launch are 1172 pounds of LOX and 683 pounds of LH2. This FPR is considered to be valid at any point in the prescribed 500 pound launch window, since a previous analysis has established that FPR variation within a larger 700 pound launch window is less than 50 pounds. Utilizing these FPR data, the table on the following page provides an assessment of the S-IVB residual propellants predicted for the nominal mission. The nominal launch time is 2.84 minutes prior to the planar flight opportunity, consequently, 96 pounds of the 500 pound launch window propellant allocation are required for yaw steering to the prescribed target conditions.

	LOX (Pounds)	LH_2 (Pounds)	Total (Pounds)
Total on board at GCS	2208	1792	4000
(1)Unuseable	440	948	1388
(2)Total Available	1768	844	2612
3 sigma FPR allocation	1172	683	1855
Remaining launch window allocation (4.8:1 EMR)	334	70	404
Total allocation	1506	753	2259
Excess available over allocation	262	91	353
Excess useable at 4.8:1 EMR	262	55	317
Excess bias	0	36	36

(1) Unuseable determined by MSFC/MDAC to assure the required 6.7 m/sec depletion cutoff thrust decay velocity increment.

(2) Total available LH_2 includes a 460 pound bias.

The preceding table is a modification of the residual propellant assessment provided in the ASTP (SA-210) OT documentation, using the actual FPR generated in this analysis.

SECTION 1

INTRODUCTION

Launch vehicle performance is predictable only within certain tolerances. Therefore, deviations from a predicted launch vehicle trajectory are expected. In order to establish realistic deviation limits for the ASTP (SA-210) Launch Vehicle Operational Flight Trajectory, a dispersion analysis has been conducted and is documented in this report.

The nominal trajectory prescribed for this analysis is the ASTP (SA-210) Launch Vehicle 500 Pound Launch Window Opening OT. This trajectory is documented in Reference 1.

The error sources considered are those associated with predictions of vehicle characteristics, vehicle systems performances, and flight environment. The nominal vehicle, the boost trajectory simulations, the error sources, the analytic procedures utilized, and the results are discussed in the following sections.

Launch vehicle guidance system inaccuracies were determined from the guidance error analysis, which is documented in Volume II of this publication (Reference 2). These data are composed of individual error source trajectory effects, which are statistically combined to provide trajectory parameter dispersion envelopes. Fixed time state variable cards are provided with Volume II to facilitate orbital trajectory dispersion analyses.

SECTION 2

DISCUSSION

2.1 Mission Description

The Apollo Soyuz Test Project (ASTP) is a joint USA and USSR venture consisting of separate Apollo and Soyuz spacecraft launches for an earth orbit rendezvous and docking. The Soyuz will be launched first on July 15, 1975 and inserted into a 188/228 km. (101.5/123.1 n.mi.) earth orbit inclined at 51.78 degrees. Subsequently, the Soyuz orbit will be circularized at 225 km. (121.5 n.mi.). Approximately 7½ hours after the Soyuz launch, the Apollo spacecraft will be launched and inserted into a 150/167 km. (81/90 n.mi.) earth orbit coplanar with the Soyuz orbit. The Apollo will then rendezvous and dock with the Soyuz. The two spacecraft will remain docked for approximately two days, during which time the crews will exchange visits and operational procedures. After additional docking tests, the spacecraft will separate and conduct independent activities. The Soyuz will deorbit approximately 46 hours after the initial undocking, and the Apollo will remain in orbit, conducting experiments, for five additional days.

2.2 Launch Vehicle and Trajectory Description

The launch vehicle and typical trajectories are described in Reference 1. Features pertinent to this analysis are discussed in the following subsections. Associated dispersion data are discussed in subsections 2.3 and 2.4.

2.2.1 Launch Vehicle

The Apollo launch vehicle is Saturn IB 210. It is composed of the

S-IB-10 first stage, an interstage, the S-IVB-210 second stage, and the S-IU-210 Instrument Unit. Major spacecraft elements are the CM-111 Command Module, the SM-111 Service Module, the SLA-18 Spacecraft Launch Adapter and the DM-2 Docking Module. A Launch Escape System (LES) completes the space vehicle. A vehicle weight breakdown is presented in Table 1.

2.2.2 Flight Environment

The 1963 Patrick Air Force Base atmosphere model, defined in Reference 3, is the nominal atmosphere used in this analysis. The nominal wind is the July mean profile from Reference 4 supplemented by compatible data from Reference 5 for altitudes greater than 27 kilometers.

2.2.3 Flight Sequence of Events

The nominal flight sequence of events, for this analysis, is presented in Table 2. Off nominal propulsion systems performances produce significant sequence changes. Of primary interest are the events which establish Launch Vehicle Digital Computer (LVDC) time bases and thus the subsequent events dependent on these time bases. A discussion of pertinent time bases and associated events follows.

1) Time Base 2 (T2) - Established by S-IB stage propellant level sensor actuation if a downrange velocity ≥ 500 m/sec exists. Significant dependent events are Inboard Engine Cut-Off Signal (IECO), interconnection of thrust O.K. switches and fuel depletion probe arming.

2) Time Base 3 (T3) - Established when an Outboard Engine Cut-Off Signal (OECO) is received by the LVDC due to either LOX or fuel

depletion; or, by a backup LVDC signal initiated 13.00 seconds after establishment of Time Base 2. Pertinent dependent events are ullage rocket firing, S-IB retro-rocket firing, S-IB/S-IVB separation signal, J-2 engine start signal, IGM guidance initiation, and Engine Mixture Ratio (EMR) changes.

3) Time Base 4 (T4) - Initiated approximately 0.2 seconds after Guidance Cutoff Signal (GCS). In this analysis, GCS is received when the S-IVB stage obtains the target velocity less the predicted velocity increment from J-2 thrust decay. The significant events subsequent to T4 are the preplanned orbital maneuvers and S-IVB stage ventings.

It should be noted that T2 and T3 establishments are nominally dependent upon propellant level sensor actuations and propellant depletion detection. Therefore, establishments of these time bases are very sensitive to propulsion system perturbations, which affect propellant flowrate, and thus, tank level histories.

2.3 Dispersion Error Sources

Vehicle manufacturing tolerances, predicted system performance inaccuracies, flight environment anomalies, and guidance hardware inaccuracies are sources of errors which significantly affect trajectory predictions. To facilitate statistical analyses of such error effects, three sigma tolerances have been established. The three sigma tolerances considered in this analysis, with corresponding references, are displayed in Table 3.

The LOX and RP-1 density cases presented herein were generated from July propulsion predictions utilizing the tapes delineated in Reference 11. The three sigma wind data utilized are the Reference 5 annual wind profiles.

2.4 Trajectory Dispersions and Analytical Procedures

The trajectory parameter perturbations resulting from this analysis are assumed to be random, independent, and normally distributed. These assumptions allow application of the Root-Sum-Square (RSS) statistical combination method to produce a reasonable trajectory dispersion envelope.

Dispersed trajectories were generated with each of the three sigma tolerances delineated in Table 3. Effects on pertinent trajectory parameters at S-IB/S-IVB stage separation and orbit insertion were determined and combined as follows:

$$+\,\text{RSS} = \sqrt{\Sigma(+\,\Delta P)^2}\ ;$$

$$-\,\text{RSS} = \sqrt{\Sigma(-\,\Delta P)^2}\ ;\ \text{where}$$

$$\Delta P = \text{perturbed parameter - nominal parameter.}$$

These RSS values define a reasonable three sigma flight envelope for the ASTP (SA-210) Launch Vehicle Operational Flight Trajectory. In a similar manner, utilizing trajectory dispersion data, the S-IVB Flight Performance Reserve (FPR), required to offset the combined three sigma deviations, was determined. This FPR and other trajectory dispersion results are presented in Section 3.

SECTION 3

RESULTS

3.1 Trajectory Dispersions

Trajectory dispersion data are presented for two events, S-IB/S-IVB stage separat on and orbit insertion. Table 4 presents three sigma trajectory parameter deviations produced at S-IB/S-IVB separation by the S-IB stage propulsion, non-propulsion, and flight environment perturbations. Table 5 provides similar data derived from S-IVB stage perturbations. Tables 7 and 8 display corresponding data at orbit insertion. In the event that both ± three sigma perturbations of the same error source produce effects with like algebraic sign, only the larger effect is included in the RSS.

Tables 6 and 9 display predicted three sigma flight envelopes at S-IB/S-IVB separation and at orbit insertion, respectively. These envelopes are the root-sum-square of the previously mentioned error source group effects with the RSS of the Inertial Measurement Unit (IMU) error effects included in Table 9. Individual IMU error effects are provided in Reference 2.

Results of the analysis show that the expected extreme deviations for T2 are +2.70 and -2.53 seconds. Analysis also reveals that the maximum deviations expected for T3 are +2.82 seconds and -2.65 seconds. Since S-IB/S-IVB stage separation, J-2 ignition, and IGM initiation times are dependent on T3, the maximum expected deviations for these events are the same as those of T3. This fact is reflected in Table 6 for S-IB/S-IVB stage separation.

A basic criterion for Launch Escape System (LES) jettisoning is that dynamic pressure (q) has decreased to one pound per square foot (psf). Therefore, the three sigma dispersion on the time this occurs was determined to facilitate selection of a satisfactory LES jettison time. It was found that q = 1 psf may occur as early as T3 +20.81 seconds or as late as T3 +31.01 seconds. These extremes reflect deviations of -4.83 seconds, and +5.37 seconds, respectively, from the nominal T3 + 25.64 seconds. Thus, current OT simulation LES jettison time of T3 + 32 seconds provides 3σ probability that $q \leq 1$ psf.

The S-IVB stage EMR step down is a T3 event, therefore the expected deviation extremes are those presented previously for T3. It is found that the maximum expected variations in T4 are +10.99 seconds and -10.46 seconds as shown in Table 9. These variations are primarily due to S-IVB propulsion perturbations.

The error sources prescribed for this analysis, Table 3, do not include conditions and tolerances which contribute to a realistic vehicle attitude rate envelope determination at S-IB/S-IVB physical separation or orbit insertion. Consequently, the total attitude rate envelopes have been omitted from Tables 6 and 9.

During S-IVB stage flight, roll control is maintained by the Auxiliary Propulsion System (APS). This system also assumes pitch and yaw control at T4 + 3.5 seconds. Essentially, the APS corrects attitude errors when the attitude error signals exceed one degree. These criteria allow attitude errors to approach ± one degree at orbit insertion, thus a two degree APS deadband exists. Consequently, attitude differences (dispersed - nominal) could be increased by nearly two degrees due to the APS deadband if the dispersion and the nominal attitude errors approached opposite deadband limits. Such an increase would be compounded by the RSS process, therefore, this method is not applicable for attitude dispersion envelope derivations at orbit insertion. Accordingly, attitude envelopes have been excluded from Table 9. These attitude envelopes as well as the attitude rate envelopes discussed in the previous paragraph are currently derived at MSFC by an alternate method.

Three sigma dispersion envelopes of pertinent design parameters during S-IB stage flight are displayed in Table 10. Tables 11 and 12 provide pertinent performance trade-off factors at S-IB/S-IVB separation and orbit insertion, respectively. Table 13 exhibits the effects at orbit insertion of large guidance platform azimuth misalignments. Such misalignments may result from ground control equipment inaccuracies in the event that a backup alignment scheme is employed. These effects are not included in the three sigma envelopes presented herein.

3.2 S-IVB Stage Flight Performance Reserve

The S-IVB stage 3σ Flight Performance Reserve (FPR) requirements for this mission are derived in Table 14. The requirements are 1172 pounds of LOX and 683 pounds of LH_2. A previous analysis, documented in Reference 19, has established that FPR variation within a 700 pound launch window is less than 50 pounds. Therefore, this FPR is considered valid at any point in the specified 500 pound launch window. Utilizing this FPR, the residual S-IVB propellant assessment presented in Reference 1 is modified in the following table.

	LOX (Pounds)	LH2 (Pounds)	Total (Pounds)
Total on board at GCS	2208	1792	4000
(1) Unuseable	440	948	1338
(2) Total Available	1768	844	2612
3 sigma FPR allocation	1172	683	1855
Remaining launch window allocation (4.8:1 EMR)	334	70	404
Total allocation	1506	753	2259
Excess available over allocation	262	91	353
Excess useable at 4.8:1 EMR	262	55	317
Excess bias	0	36	36

(1) Unuseable determined by MSFC/MDAC to assure the required 6.7 m/sec depletion cutoff thrust decay velocity increment.

(2) Total available LH_2 includes a 460 pound bias.

Table 14 also contains significant individual perturbation effects on the S-IVB stage propellant components consumed and the readily applicable trade-off factors. Utilizing the proper algebraic sign, these trade-off factors provide quick estimates of perturbation effects on S-IVB propellants consumed.

SECTION 4

GOVERNMENT FURNISHED DOCUMENTATION

The GFD for this analysis is listed below.

GOVERNMENT FURNISHED DOCUMENTATION
DRL 444-V4a, VOLUME I

MSFC APPROVAL DATE	DESCRIPTION OF GFD REQUIRED	IDENTIFICATION OF GFD PRESCRIBED
12/13/74, 12/18/74 and 2/3/75	L/V mass characteristics consistent with propulsion dispersion data.	MSFC Computer Card Decks 513A (Rev. 2), 513B (Rev. 1), 515A (Rev. 1) through 515G (Rev. 1), and 515H through 515S; MSFC/CCSD Telecons - R. Bailey to N. Williams, 12/16/74 and 12/18/74.
12/13/74 and 12/18/74	L/V propulsion dispersion data.	TR-P&VE-75-222; S&E-ASTN-SAB (71-9); S&E-ASTN-SAB (72-20); S&E-AERO-MFP-31-74; GFDA for ASTP (SA-210) DRL 444-V4; MSFC/CCSD Telecons - R. Bailey to N. Williams/R. Blackstock, 12/16/74, 12/17/74, and 12/18/74.
12/13/74	Error sources and tolerances.	TN-AP-68-312; R-P&VE-VAW-66-119; R-AERO-F-27-67; TM-53956; S&E-AERO-YT-91-71; S&E-ASTR-SC-36-69; R-P&VE-PPE-66-M-99; S&E-AERO-MFG-138-70; TN-FT-74-19.
12/13/74	Time for fixed-time state variable card generation.	700 Seconds Flight Time.
2/3/75	Nominal Trajectory.	ASTP (SA-210) L/V 500 Pound Launch Window Opening OT (Updated).

SECTION 5

REFERENCES

1. CCSD TN-FT-74-35, ASTP (SA-210) Launch Vehicle Operational Flight Trajectory, Part III, Final Documentation, dated January 21, 1975: as updated by CCSD Letter, R. M. Blackstock to J. L. Crafts, dated February 7, 1975.

2. CCSD TN-FT-75-43, ASTP (SA-210) Launch Vehicle Operational Flight Trajectory Dispersion Analysis, Volume II, Guidance Hardware Error Analysis (U), dated April 4, 1975.

3. NASA/MSFC TMX-53139, A Reference Atmosphere for Patrick AFB, Florida, Annual (1963 Revision), dated September 23, 1964.

4. NASA/MSFC S&E-AERO-YT-77-71, Subject: Monthly Vector Mean Winds Versus Altitude for Cape Kennedy, Florida, for Skylab (INT-21) Wind Bias Trajectory Analysis, dated January 29, 1971.

5. NASA/MSFC TM-53956, Cape Kennedy Wind Component Statistics Monthly and Annual Reference Periods for All Flight Azimuths from 0 to 70 KM Altitude, dated October 9, 1969.

6. NASA/MSFC R-AERO-F-27-67, Subject: S-IB, S-IVB Three Sigma Tolerance Envelope for Use in the Stage Incentive Plan for Vehicles AS-207 through AS-212, dated February 10, 1967 (U).

7. CCSD TN-AP-68-312, SA-206/LM and SA-207/CSM Aerodynamic Axial Force Characteristics - Mission 276, dated March 1, 1968

8. NASA/MSFC R-P&VE-VAW-66-119, Subject: Saturn IB Three-Sigma Radial Center of Gravity Deviation During First Stage Flight, dated November 30, 1966.

9. NASA/MSFC S&E-AERO-YT-91-71, Subject: Computer Subroutines for the Cape Kennedy Hot and Cold Atmospheres, 1971, dated July 23, 1971.

10. NASA/MSFC S&E-ASTN-SAB (71-9), Subject: S-IB Stage Propulsion System Dispersions for Skylab Missions, dated May 6, 1971.

11. CCSD TR-P&VE-75-222, Final Launch Vehicle Propulsion Systems Flight Performance Prediction for SA-210, dated January 31, 1975.

12. NASA/MSFC Computer Card Decks 513A (Rev. 2), 513B (Rev. 1), 515A (Rev. 1) through 515G (Rev. 1), and 515H through 515S.

13. NASA/MSFC R-P&VE-PPE-66-M-99, Subject: S-IB Stage 200K and 205K H-1 Engine Thrust Decay Profiles, dated June 3, 1966.

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14. NASA/MSFC S&E-AERO-MFG-138-70, Subject: Sign Convention to be Used in Dispersion Analysis of ST-124M Platform Hardware Errors for Saturn V and Saturn IB Vehicles, dated November 10, 1970.

15. NASA/MSFC S&E-ASTR-SG-36-69, Subject: ST-124M Platform Hardware Errors to be Used in Performing a Hardware Error Analysis for the Saturn IB and Saturn V Launch Vehicles, dated September 25, 1969 (U).

16. NASA/MSFC S&E-ASTN-SAB (72-20), Subject: Saturn IB Vehicle Engine Start and Shutdown Performance Characteristics Predicted for Skylab and Subsequent Missions, dated December 12, 1972.

17. MSFC/CCSD Telecon - R. Bailey to R Blackstock, Subject: ASTP (SA-210) L/V Operational Trajectory Dispersion Analysis, DRL 444-V4, December 17, 1974.

18. NASA/MSFC GFD/Groundrule Approval Sheet, Task: ASTP (SA-210) Saturn IB Vehicle Operational Flight Trajectory Dispersion Analysis, DRL 444-V4, approved 12-13-74; and Revision A, approved 2-3-75.

19. CCSD TN-AP-71-492, Skylab/Saturn IB Launch Window Dispersion Analysis, Part I, dated June 30, 1971.

20. CCSD TN-FT-74-19, ASTP (SA-210) Launch Vehicle Preliminary Operational Flight Trajectory Dispersion Analysis, Volume I, dated July 15, 1974.

21. MSFC/CCSD Telecons - R. Bailey to N. Williams, Subject: Corrections to ASTP (SA-210) L/V OT Dispersion Analysis GFD, December 16, 1974 and December 18, 1974.

TABLE 1

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
VEHICLE WEIGHT BREAKDOWN
500 POUND LAUNCH WINDOW OPENING TRAJECTORY
(POUNDS)

DM	4,492	
SM	15,446	
CM	12,955	
SLA Panels	2,343	
SLA (Fixed)	2,164	
Instrument Unit	4,099	
*S-IVB Stage	25,108	
**Useable S-IVB Propellant	1,733	
Orbit Insertion Weight		68,340
LOX Vented	11	
J-2 Thrust Decay and Drain Propellant	121	
S-IVB Cutoff Weight		68,472
S-IVB Propellant Consumed	229,476	
S-IVB APS Propellant Consumed	6	
LES	9,151	
Ullage Cases	214	
S-IVB "90% Thrust" Weight		307,319
S-IVB GH2 Start Tank	4	
S-IVB Buildup Propellant Consumed	383	
Ullage Propellant Consumed	176	
S-IVB Weight at Separation		307,882
S-IVB Aft Frame Hardware	31	
S-IB/S-IVB Interstage	6,718	
S-IB Dry Weight	84,410	
S-IB Residuals and Reserves	10,200	
S-IVB Detonation Package	5	
S-IVB Frost Dissipated	200	
S-IB Frost Dissipated	1,000	
S-IB Seal Purge Consumed (N2)	6	
S-IB Fuel Additive Consumed (Oronite)	27	
S-IB Gearbox Consumption (RP-1)	699	
Inboard Engine Thrust Decay Prpt. Consumed	2,181	
Outboard Engine Thrust Decay Prpt. Consumed to Separation	1,529	
S-IB Mainstage Propellant Consumed	881,519	
Vehicle Weight at First Motion		1,296,407

* Includes sufficient useable propellant to assure the required 6.7 m/s depletion thrust decay velocity increment and a 460 pound LH2 bias.

** Composed of 1,434 pounds of LOX and 299 pounds of LH2.

TABLE 2

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY
FLIGHT SEQUENCE OF EVENTS
500 POUND LAUNCH WINDOW OPENING TRAJECTORY

FLIGHT TIME (HR: MIN: SEC)	FLIGHT TIME (SEC)	LVDC FLIGHT PROGRAM TIME(SEC)	EVENT
-0:00:17.20	- 17.20	$(0.00)_0$	Guidance Reference Release (GRR); Initiation of Time Base 0.
-0:00:03.30	- 3.30	---	Time for S-IB Mainstage Ignition.
-0:00:00.20	- 0.20	---	Hold Down Arm Release Signal.
0:00:00.00	0.00	---	First Motion.
0:00:00.20	0.20	$(0.00)_1$	Lift-Off Signal; Initiate Time Base 1.
0:00:10.00	10.00	$(9.80)_1$	Initiate Pitch and Roll Maneuvers.
0:00:57.74	57.74	---	Mach One.
0:01:13.20	73.20	---	Maximum Dynamic Pressure.
0:01:40.20	100.20	$(100.00)_1$	Control Gain Switch Point.
0:02:00.20	120.20	$(120.00)_1$	Control Gain Switch Point.
0:02:08.07	128.07	$(127.87)_1$	Enable S-IB Propellant Level Sensors.
0:02:09.00	129.00	$(128.80)_1$	Arrest Attitude Commands.
0:02:13.07	133.07	$(0.00)_2$	Level Sensor Actuation; Initiate Time Base 2.
0:02:16.07	136.07	$(3.00)_2$	Inboard Engine Cutoff (IECO).
0:02:19.47	139.47	$(0.00)_3$	Outboard Engine Cutoff (OECO); Initiate Time Base 3.
0:02:20.57	140.57	$(1.10)_3$	Ullage Rockets Ignition.
0:02:20.77	140.77	$(1.30)_3$	Separation Signal.
0:02:20.85	140.85	---	S-IB/S-IVB Physical Separation.
0:02:22.17	142.17	$(2.70)_3$	J-2 Engine Start Command.
0:02:25.57	145.57	---	90% J-2 Thrust Level.
0:02:28.17	148.17	$(8.70)_3$	Command 5.5:1 EMR.
0:02:28.57	148.57	---	Ullage Burn Out.
0:02:32.77	152.77	$(13.30)_3$	Jettison Ullage Rocket Motors.
0:02:45.11	165.11	---	Dynamic Pressure = 1 PSF.
0:02:51.47	171.47	---	LES Jettison.
0:02:54.47	174.47	$(35.00)_3$	Command Active Guidance Initiation.
0:03:01.47	181.47	$(42.00)_3$	Control Gain Switch Point.
0:05:43.17	343.17	$(203.70)_3$	Control Gain Switch Point.
0:07:47.57	467.57	$(328.10)_3$	Command EMR Shift to 4.8:1.
0:09:44.07	584.07	---	Guidance Cutoff Signal (GCS).
0:09:44.27	584.27	$(0.00)_4$	Initiate Time Base 4; Inertial Attitude Freeze.
0:09:44.87	584.87	$(0.60)_4$	Initiate LOX NPV.
0:09:54.07	594.07	---	Orbit Insertion.
0:09:54.67	594.67	$(10.40)_4$	Initiate LH_2 NPV.
0:10:04.27	604.27	$(20.00)_4$	Initiate a maneuver to align and maintain the S-IVB/CSM along the local horizontal, nose leading, position 1 down.
0:10:44.87	644.87	$(60.60)_4$	End LOX NPV.
0:11:40.00	700.00	---	End of trajectory simulation.

TABLE 3

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
THREE SIGMA TOLERANCES

GROUP	ITEM	TOLERANCE	REFERENCE
S-IB Stage Non-Propulsion	Non-Propellant Mass	± 310 Pounds	6
	Thrust Misalignment (Pitch)	± 0.62 Degrees	6
	Thrust Misalignment (Yaw)	± 0.62 Degrees	6
	Thrust Misalignment (Roll)	± 0.62 Degrees	6
	Axial Force Coefficient	Maximum	7
	Axial Force Coefficient	Minimum	7
	*Center of Gravity Offset (y)	± 0.05 Meters	8
	*Center of Gravity Offset (z)	± 0.05 Meters	8
Environment	Headwind	Annual } 3 σ where available, maximum otherwise	5
	Tailwind	Annual	5
	Right Cross Wind	Annual	5
	Left Cross Wind	Annual	5
	Atmosphere	Hot Atmosphere Profile	9
	Atmosphere	Cold Atmosphere Profile	9
S-IB Stage Propulsion	High LOX Density	- 3σ July Surface Winds	10, 11 & 12
	Low LOX Density	+ 3σ July Surface Winds	10, 11 & 12
	High Fuel Density	- 3σ July Surface Temp.	10, 11 & 12
	Low Fuel Density	+ 3σ July Surface Temp.	10, 11 & 12
	Fuel Mass	+ 0.60%	10
	Fuel Mass	- 0.60%	10, 11 & 12
	LOX Mass	+ 0.45%	10, 11 & 12
	LOX Mass	- 0.60%	10
	Thrust and Flowrate	± 1.5 %	10
	ISP and Flowrate	± 1.95 Seconds	10
	Engine Mixture Ratio	+ 2800 Pound Max. Residual	10
	Engine Mixture Ratio	- 1550 Pound Min. Residual	10, 11 & 12
	H-1 Engine Thrust Decay	± RSS of 22.5% of Nominal Thrust Decay Impulse For Each H-1 Engine	13
S-IVB Stage Non-Propulsion	Non-Propellant Mass	± 200 Pounds	6
	*Center of Gravity Offset (y)	± 0.05 Meters	6
	*Center of Gravity Offset (z)	± 0.05 Meters	6
	Thrust Misalignment (Pitch)	± 1.24 Degrees	6
	Thrust Misalignment (Yaw)	± 1.24 Degrees	6
Instrument Unit	Inertial Measurement Units	---	14 & 15

* Referenced to Project Apollo Standard Coordinate System 9.

TABLE 3 (CONTINUED)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
THREE SIGMA TOLERANCES

GROUP	ITEM	TOLERANCE	REFERENCE
S-IVB Stage Propulsion	J-2 Thrust Decay Cases 1 through 12	Dispersion Limits Identified below	16 & 18

S-IVB Stage Engine Performance Dispersions

MSFC Tape No.	Case	Deviations from Nominal					
		LH2 Flowrate (lbs/sec)	LOX Flowrate (lbs/sec)	Total Flowrate (lbs/sec)	Engine Mixture Ratio	Specific Impulse (secs)	Thrust (lbs)
00029	1	+0.830	+7.526	+8.356	+0.035	+0.233	+3678.
00169	2	-0.830	-7.526	-8.356	-0.035	-0.233	-3678
00254	3	+0.396	+0.659	+1.055	-0.018	+1.935	+1504.
00562	4	-0.396	-0.659	-1.055	+0.018	-1.935	-1504.
00701	5	+1.083	-0.167	+0.917	-0.072	-0.074	+ 349.
00758	6	-1.083	+0.167	-0.917	+0.072	+0.074	- 349.
00916	7	+0.253	+3.053	+3.306	+0.020	-0.097	+1350.
01059	8	-0.253	-3.053	-3.306	-0.020	+0.097	-1350.
*28311	9	+0.645% LOX Load					
*28311	10	-0.645% LOX Load					
*28311	11	+0.902% Fuel Load					
*28311	12	-0.902% Fuel Load					

* Nominal ASTP (SA-210) Launch Vehicle Operational Flight Trajectory Propulsion Data.

TABLE 4

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT S-IB/S-IVB SEPARATION
S-IB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	RADIUS (M)	SPACE FIXED VELOCITY (M/S)	SPACE FIXED FLIGHT PATH ANGLE (DEG)	GROUND RANGE (M)	EARTH FIXED CROSS RANGE (M)	VEHICLE WEIGHT (LB)
NOMINAL	140.85	6431838.	2318.85	66.391	66342.	-451.	409246.
HIGH LOX DENSITY	-.71	256.	-5.21	-.302	-711.	4.	1078.
LOW LOX DENSITY	.99	-463.	4.84	.434	928.	-6.	-1344.
HIGH FUEL DENSITY	1.01	-640.	.12	.480	821.	-5.	25.
LOW FUEL DENSITY	-.58	365.	-.22	-.285	-479.	3.	-58.
PRPT. LOADING MASS + LOX	.58	141.	12.46	.171	817.	-4.	-1072.
PRPT. LOADING MASS - LOX	-.65	-209.	-17.46	-.254	-1170.	5.	1599.
PRPT. LOADING MASS + RP-1	.00	-279.	-7.32	.061	-193.	1.	1674.
PRPT. LOADING MASS - RP-1	-.17	153.	6.23	-.101	-95.	1.	-1410.
THRUST AND FLOWRATE (+)	-2.09	1321.	3.34	-1.044	-1709.	10.	-45.
THRUST AND FLOWRATE (-)	2.16	-1391.	-3.86	1.017	1705.	-11.	44.
ISP AND FLOWRATE (+,-)	.93	503.	18.82	.229	1391.	-7.	-18.
ISP AND FLOWRATE (-,+)	-.93	-505.	-18.83	-.235	-1376.	7.	-31.
E.M.R. MAXIMUM RESIDUAL	-.46	-451.	-17.86	-.063	-866.	4.	2781.
E.M.R. MINIMUM RESIDUAL	.25	232.	10.36	.035	472.	-2.	-1596.
H-1 ENGINE THRUST DECAY (+)	.00	1.	.77	-.001	2.	-0.	0.
H-1 ENGINE THRUST DECAY (-)	.00	-1.	-.70	.001	-2.	-0.	0.
NON-PROPELLANT MASS (+)	.00	-52.	-1.36	.011	-36.	0.	310.
NON-PROPELLANT MASS (-)	.00	52.	1.36	-.011	36.	-0.	-310.
THRUST MIS. + PITCH	.00	-1056.	13.26	1.253	1430.	171.	0.
THRUST MIS. - PITCH	.00	1026.	-13.71	-1.256	-1459.	-174.	0.
THRUST MIS. + YAW	.00	-14.	-5.43	-.040	207.	-1892.	0.
THRUST MIS. - YAW	.00	-13.	5.13	.059	-182.	1893.	0.
THRUST MIS. + ROLL	.00	-2.	.04	.004	2.	34.	0.
THRUST MIS. - ROLL	.00	1.	-.04	-.003	-1.	-33.	0.
AXIAL FORCE COEF. (+)	.00	-823.	-15.95	.179	-544.	3.	0.
AXIAL FORCE COEF. (-)	.00	826.	15.43	-.177	530.	-3.	0.
C.G. OFFSET (+Y)	.00	3.	-1.21	-.012	94.	-581.	0.
C.G. OFFSET (-Y)	.00	-7.	1.16	.014	-93.	581.	0.
C.G. OFFSET (+Z)	.00	271.	-4.13	-.320	-469.	-83.	0.
C.G. OFFSET (-Z)	.00	-275.	4.06	.328	464.	82.	0.
HEADWIND	.00	88.	-12.00	-.137	-1609.	177.	0.
TAILWIND	.00	-475.	29.93	.483	3415.	196.	0.
RIGHT CROSS WIND	.00	-120.	-.81	.06	71.	-1302.	0.
LEFT CROSS WIND	.00	-88.	5.47	.119	97.	3467.	0.
HOT ATMOSPHERE PROFILE	.00	-48.	-1.98	.010	-65.	-4.	0.
COLD ATMOSPHERE PROFILE	.00	206.	4.00	-.06[illegible]	167.	9.	0.
POSITIVE RSS	2.62	2038.	45.73	1.871	4643.	4002.	3789.
NEGATIVE RSS	-2.65	-2292.	-41.42	-1.775	-3604.	-2377.	-2756

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TABLE 4 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT S-IB/S-IVB SEPARATION
S-IB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME	** SPACE FIXED POSITION VECTOR ** XS	YS	ZS **	** SPACE FIXED VELOCITY VECTOR ** XDOT	YDOT	ZDOT **
	(SEC)	(M)	(M)	(M)	(M/S)	(M/S)	(M/S)
NOMINAL	140.85	6430759.	55701.	103813.	892.04	257.19	2124.89
HIGH LOX DENSITY	-.71	272.	-181.	-933.	9.57	.25	-9.78
LOW LOX DENSITY	.99	-485.	253.	1236.	-14.80	-.36	11.52
HIGH FUEL DENSITY	1.01	-661.	258.	1131.	-18.29	-.36	7.77
LOW FUEL DENSITY	-.58	377.	-148.	-657.	10.68	.22	-4.78
PRPT. LOADING MASS + LOX	.58	123.	150.	1007.	-1.95	-.18	14.43
PRPT. LOADING MASS - LOX	-.65	-184.	-218.	-1447.	3.14	.23	-20.43
PRPT. LOADING MASS + RP-1	.00	-276.	0.	-199.	-5.02	-.01	-5.88
PRPT. LOADING MASS - RP-1	-.17	155.	-44.	-146.	6.19	.05	4.19
THRUST AND FLOWRATE (+)	-2.09	1363.	-535.	-2353.	41.14	.74	-14.16
THRUST AND FLOWRATE (-)	2.16	-1435.	551.	2366.	-40.34	-.76	12. 0
ISP AND FLOWRATE (+,-)	.93	473.	239.	1701.	-1.94	-.23	21.35
ISP AND FLOWRATE (-,+)	-.93	-476.	-240.	-1686.	2.00	.23	-21.44
E.M.R. MAXIMUM RESIDUAL	-.46	-434.	-118.	-1024.	-4.23	.11	-17.73
E.M.R. MINIMUM RESIDUAL	.25	222.	65.	558.	2.48	-.07	10.27
H-1 ENGINE THRUST DECAY (+)	.00	1.	-0.	2.	.34	-.00	.70
H-1 ENGINE THRUST DECAY (-)	.00	-1.	0.	-2.	-.31	.00	-.64
NON-PROPELLANT MASS (+)	.00	-51.	-0.	-37.	-.93	-.00	-1.09
NON-PROPELLANT MASS (-)	.00	51.	-0.	37.	.93	-.00	1.09
THRUST MIS. PITCH	.00	-1081.	156.	1428.	-42.66	.57	31.68
THRUST MIS. - PITCH	.00	1051.	-158.	-1458.	41.71	-.58	-33.02
THRUST MIS. + YAW	.00	-0.	-1893.	156.	-.21	-54.35	.05
THRUST MIS. - YAW	.00	-27.	1894.	-184.	-.61	54.41	-1.42
THRUST MIS. + ROLL	.00	-3.	34.	2.	-.11	.63	.07
THRUST MIS. - ROLL	.00	1.	-33.	-2.	.09	-.62	-.06
AXIAL FORCE COEF. (+)	.00	-814.	0.	-562.	-12.59	-.05	-12.13
AXIAL FORCE COEF. (-)	.00	818.	-0.	548.	12.41	.05	11.61
C.G. OFFSET (+Y)	.00	6.	-581.	84.	.08	-14.49	.35
C.G. OFFSET (-Y)	.00	-11.	582.	-88.	-.16	14.50	-.47
C.G. OFFSET (+Z)	.00	280.	-79.	-471.	10.79	-.28	-9.05
C.G. OFFSET (-Z)	.00	-284.	78.	465.	-10.87	.28	8.92
HEADWIND	.00	112.	187.	-1620.	.94	5.13	-14.12
TAILWIND	.00	-533.	173.	3440.	-7.96	4.88	35.28
RIGHT CROSS WIND	.00	-110.	-1303.	38.	-2.63	-13.17	1.77
LEFT CROSS WIND	.00	-120.	3466.	55.	-2.79	38.80	2.09
HOT ATMOSPHERE PROFILE	.00	-47.	-4.	-66.	-1.40	-.09	-1.56
COLD ATMOSPHERE PROFILE	.00	203.	10.	172.	3.87	.40	2.69
POSITIVE RSS	2.82	2072.	4065.	5204.	63.12	68.59	60.08
NEGATIVE RSS	-2.65	-2339.	-2473.	-4266.	-66.35	-57.78	-55.41

TABLE 4 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT S-IB/S-IVB SEPARATION
S-IB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	** EARTH FIXED POSITION VECTOR ** XE (M)	YE (M)	ZE (M)	** EARTH FIXED VELOCITY VECTOR ** XDOT (M/S)	YDOT (M/S)	ZDOT (M/S)
NOMINAL	140.85	58327.	-451.	66839.	913.03	-8.20	1808.04
HIGH LOX DENSITY	-.71	262.	4.	-716.	9.39	.07	-9.82
LOW LOX DENSITY	.99	-471.	-6.	933.	-14.56	-.10	11.60
HIGH FUEL DENSITY	1.01	-647.	-5.	823.	-18.08	-.10	7.88
LOW FUEL DENSITY	-.58	369.	3.	-480.	10.56	.07	-4.85
PRPT. LOADING MASS + LOX	.58	133.	-4.	82[illegible].	-1.73	-.04	14.40
PRPT. LOADING MASS - LOX	-.65	-199.	5.	-1182.	2.84	.03	-20.40
PRPT. LOADING MASS + RP-1	.00	-277.	1.	-197.	-5.08	.00	-5.83
PRPT. LOADING MASS - RP-1	-.17	153.	1.	-94.	6.20	.01	4.15
THRUST AND FLOWRATE (+)	-2.09	1335.	10.	-1714.	40.72	.20	-14.43
THRUST AND FLOWRATE (-)	2.16	-1406.	-11.	1708.	-39.92	-.22	12.67
ISP AND FLOWRATE (+,-)	.93	491.	-7.	1408.	-1.61	-.04	21.29
ISP AND FLOWRATE (-,+)	-.93	-494.	7.	-1393.	1.67	.04	-21.38
E.M.R. MAXIMUM RESIDUAL	-.46	-444.	4.	-876.	-4.46	.02	-17.66
E.M.R. MINIMUM RESIDUAL	.25	228.	-2.	476.	2.61	-.01	10.23
H-1 ENGINE THRUST DECAY (+)	.00	1.	-0.	2.	.35	-.00	.70
H-1 ENGINE THRUST DECAY (-)	.00	-1.	-0.	-2.	-.31	.00	-.63
NON-PROPELLANT MASS (+)	.00	-51.	0.	-3[illegible].	-.94	-.00	-1.08
NON-PROPELLANT MASS (-)	.00	51.	-0.	37.	.94	-.00	1.08
THRUST MIS. + PITCH	.00	-1069.	171.	1435.	-42.34	1.13	32.05
THRUST MIS. - PITCH	.00	1039.	-174.	-1465.	41.37	-1.13	-33.37
THRUST MIS. + YAW	.00	-12.	-1892.	166.	-.65	-54.34	.42
THRUST MIS. - YAW	.00	-16.	1893.	-194.	-.19	54.40	-1.78
THRUST MIS. + ROLL	.00	-2.	34.	[illegible]	-.10	.63	.07
THRUST MIS. - ROLL	.00	1.	-33.	-2.	.08	-.62	-.06
AXIAL FORCE COEF. (+)	.00	-818.	3.	-556.	-12.71	-.01	-11.99
AXIAL FORCE COEF. (-)	.00	822.	-3.	542.	12.53	.02	11.48
C.G. OFFSET (+Y)	.00	3.	-581.	86.	-.03	-14.49	.45
C.G. OFFSET (-Y)	.00	-8.	581.	-91.	-.04	14.49	-.57
C.G. OFFSET (+Z)	.00	275.	-83.	-472.	10.69	-.43	-9.14
C.G. OFFSET (-Z)	.00	-280.	82.	467.	-10.78	.43	9.01
HEADWIND	.00	101.	177.	-1622.	.79	4.99	-14.17
TAILWIND	.00	-506.	196.	3445.	-7.48	5.27	35.33
RIGHT CROSS WIND	.00	-118.	-1302.	46.	-2.76	-13.13	1.92
LEFT CROSS WIND	.00	-96.	3467.	37.	-2.37	38.84	1.78
HOT ATMOSPHERE PROFILE	.00	-47.	-4.	-66.	-1.42	-.09	-1.55
COLD ATMOSPHERE PROFILE	.00	204.	9.	170.	3.91	.39	2.65
POSITIVE RSS	2.82	2051.	4002.	4675.	62.56	68.61	60.34
NEGATIVE RSS	-2.65	-2311.	-2377.	-363[illegible].	-65.74	-57.77	-55.65

TABLE 4 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT S-IB/S-IVB SEPARATION
S-IB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	** VEHICLE ATTITUDE ** PITCH (DEG)	YAW (DEG)	ROLL (DEG) **	** VEHICLE ATTITUDE RATE ** PITCH (DEG/S)	YAW (DEG/S)	ROLL (DEG/S) **
NOMINAL	140.85	-64.008	-.096	.000	.006	-.023	-.000
HIGH LOX DENSITY	-.71	-.017	.001	.002	-.012	.001	.002
LOW LOX DENSITY	.99	.026	-.003	-.003	.019	-.002	-.004
HIGH FUEL DENSITY	1.01	.029	-.003	-.004	.021	-.003	-.004
LOW FUEL DENSITY	-.58	-.015	.002	.002	-.011	.002	.002
PRPT. LOADING MASS + LOX	.58	.011	.001	-.001	.008	.001	-.001
PRPT. LOADING MASS - LOX	-.85	-.017	-.001	.002	-.011	-.001	.002
PRPT. LOADING MASS + RP-1	.00	.002	-.001	-.000	.002	-.001	-.000
PRPT. LOADING MASS - RP-1	-.17	-.004	.004	.006	-.003	.003	.001
THRUST AND FLOWRATE (+)	-2.09	-.050	.006	.006	-.037	.005	.007
THRUST AND FLOWRATE (-)	2.16	.065	-.007	-.008	.048	-.006	-.009
ISP AND FLOWRATE (+,-)	.93	.015	.002	-.002	.010	.002	-.002
ISP AND FLOWRATE (-,+)	-.93	-.017	-.002	.002	-.011	-.002	.002
E.M.R. MAXIMUM RESIDUAL	-.46	-.006	-.002	.001	-.004	-.002	.001
E.M.R. MINIMUM RESIDUAL	.25	.003	.001	-.000	.002	.001	-.000
H-1 ENGINE THRUST DECAY (+)	.00	.000	.001	-.000	.000	.000	-.000
H-1 ENGINE THRUST DECAY (-)	.00	-.000	-.000	.000	-.000	-.000	.000
NON-PROPELLANT MASS (+)	.00	.000	-.000	-.001	.000	-.000	-.000
NON-PROPELLANT MASS (-)	.00	-.000	.000	.000	-.000	.000	.000
THRUST MIS. + PITCH	.00	-1.550	-.007	-.001	.008	-.006	.002
THRUST MIS. - PITCH	.00	1.548	.007	.001	-.008	.005	-.002
THRUST MIS. + YAW	.00	.000	-1.545	.000	.000	.010	-.000
THRUST MIS. - YAW	.00	-.000	1.544	-.000	-.000	-.010	.000
THRUST MIS. + ROLL	.00	-.002	-.001	-3.643	-.001	-.000	-.001
THRUST MIS. - ROLL	.00	.002	.001	3.649	.001	.000	.001
AXIAL FORCE COEF. (+)	.00	.008	-.004	-.001	.007	-.003	-.001
AXIAL FORCE COEF. (-)	.00	-.007	.004	.001	-.006	.002	.001
C.G. OFFSET (+Y)	.00	.000	-.171	.002	.000	.010	.000
C.G. OFFSET (-Y)	.00	-.000	.172	-.002	-.000	-.010	-.000
C.G. OFFSET (+Z)	.00	.173	.002	.012	-.009	.002	.013
C.G. OFFSET (-Z)	.00	-.172	-.002	-.014	.010	-.002	-.014
HEADWIND	.00	.004	.041	.000	.004	.028	-.000
TAILWIND	.00	-.060	.039	.008	-.049	.027	.009
RIGHT CROSS WIND	.00	-.015	-.016	.002	-.011	-.013	.002
LEFT CROSS WIND	.00	-.017	.104	.004	-.012	.077	.004
HOT ATMOSPHERE PROFILE	.00	-.002	-.008	-.000	.001	-.005	-.000
COLD ATMOSPHERE PROFILE	.00	-.000	.010	.000	-.003	.007	.000
POSITIVE RSS	2.82	1.560	1.558	3.649	.059	.084	.018
NEGATIVE RSS	-2.65	-1.562	-1.554	-3.649	-.069	-.022	-.018

TABLE 4 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT S-IB/S-IVB SEPARATION
S-IB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	GEODETIC LATITUDE (DEG)	LONGITUDE POSITIVE EAST (DEG)	EARTH FIXED VELOCITY (M/S)	EARTH FIXED PATH ANGLE (DEG)	ALTITUDE (M)	SPACE FIXED AZIMUTH (DEG)
NOMINAL	140.85	29.027	-80.115	2025.51	62.719	58675.	55.762
HIGH LOX DENSITY	-.71	-.004	-.005	-4.50	-.357	254.	.032
LOW LOX DENSITY	.99	.006	.007	3.87	.506	-461.	-.038
HIGH FUEL DENSITY	1.01	.005	.006	-1.02	.550	-639.	-.026
LOW FUEL DENSITY	-.58	-.003	-.004	.46	-.324	364.	.016
PRPT. LOADING MASS + LOX	.58	.005	.006	12.04	.219	142.	-.046
PRPT. LOADING MASS - LOX	-.65	-.007	-.009	-16.84	-.324	-211.	.065
PRPT. LOADING MASS + RP-1	.00	-.001	-.001	-7.49	.056	-279.	.019
PRPT. LOADING MASS - RP-1	-.17	-.001	-.001	6.50	-.102	152.	-.014
THRUST AND FLOWRATE (+)	-2.09	-.010	-.013	5.93	-1.193	1317.	.048
THRUST AND FLOWRATE (-)	2.16	.010	.013	-6.26	1.158	-1388.	-.042
ISP AND FLOWRATE (+,-)	.93	.008	.011	18.31	.297	505.	-.066
ISP AND FLOWRATE (-,+)	-.93	-.008	-.011	-18.30	-.305	-508.	.067
E.M.R. MAXIMUM RESIDUAL	-.46	-.005	-.007	-17.77	-.106	-453.	.056
E.M.R. MINIMUM RESIDUAL	.25	.003	.004	10.31	.060	233.	-.032
H-1 ENGINE THRUST DECAY (+)	.00	.000	.000	.78	.090	1.	-.002
H-1 ENGINE THRUST DECAY (-)	.00	-.000	-.000	-.71	-.000	-1.	.002
NON-PROPELLANT MASS (+)	.00	-.000	-.000	-1.39	.010	-52.	.003
NON-PROPELLANT MASS (-)	.00	.000	.000	1.39	-.010	52.	-.003
THRUST MIS. + PITCH	.00	.007	.012	10.19	1.457	-1054.	-.070
THRUST MIS. - PITCH	.00	-.008	-.012	-10.47	-1.465	1023.	.077
THRUST MIS. + YAW	.00	.014	-.011	1.03	.037	-10.	-1.458
THRUST MIS. - YAW	.00	-.014	.011	-1.16	-.013	-18.	1.456
THRUST MIS. + ROLL	.00	-.000	.000	.01	.003	-2.	.017
THRUST MIS. - ROLL	.00	.000	-.000	-.02	-.003	1.	-.016
AXIAL FORCE COEF. (+)	.00	-.003	-.004	-16.43	.174	-824.	.037
AXIAL FORCE COEF. (-)	.00	.003	.004	15.90	-.173	827.	-.035
C.G. OFFSET (+Y)	.00	.004	-.003	.50	.008	4.	-.389
C.G. OFFSET (-Y)	.00	-.004	.003	-.53	-.006	-8.	.389
C.G. OFFSET (+Z)	.00	-.002	-.004	-3.29	-.383	271.	.017
C.G. OFFSET (-Z)	.00	.002	.004	3.23	.382	-275.	-.017
HEADWIND	.00	-.011	-.011	-12.29	-.188	84.	.176
TAILWIND	.00	.019	.028	28.27	.599	-469.	.034
RIGHT CROSS WIND	.00	.009	-.008	.57	.096	-118.	-.357
LEFT CROSS WIND	.00	-.023	.024	.74	.082	-95.	1.028
HOT ATMOSPHERE PROFILE	.00	-.000	-.001	-2.02	.017	-48.	.003
COLD ATMOSPHERE PROFILE	.00	.001	.001	4.12	-.066	206.	.002
POSITIVE RSS	2.82	.031	.045	45.22	2.171	2036.	1.839
NEGATIVE RSS	-2.65	-.035	-.031	-40.03	-2.059	-2288.	-1.556

TABLE 5

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT S-IB/S-IVB SEPARATION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	RADIUS (M)	SPACE FIXED VELOCITY (M/S)	SPACE FIXED FLIGHT PATH ANGLE (DEG)	GROUND RANGE (M)	EARTH FIXED CROSS RANGE (M)	VEHICLE WEIGHT (LB)
NOMINAL	140.85	6431238.	2318.85	66.398	66342.	-451.	409246.
PRPT. LOADING MASS + LOX	.00	-210.	-5.51	.046	-145.	1.	1259.
PRPT. LOADING MASS - LOX	.00	211.	5.53	-.046	145.	-1.	-1259.
PRPT. LOADING MASS + LH2	.00	-58.	-1.53	.013	-40.	0.	349.
PRPT. LOADING MASS - LH2	.00	58.	1.54	-.013	40.	-0.	-349.
NON-PROPELLANT MASS (+)	.00	-33.	-.84	.007	-23.	0.	200.
NON-PROPELLANT MASS (-)	.00	33.	.84	-.007	23.	-0.	-200.
POSITIVE RSS	.00	221.	5.86	.048	153.	1.	1322.
NEGATIVE RSS	.00	-221.	-5.78	-.048	-152.	-1.	-1322.

TABLE 5 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT S-IB/S-IVB SEPARATION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	** SPACE FIXED POSITION VECTOR ** XS (M)	YS (M)	ZS (M)	** SPACE FIXED VELOCITY VECTOR ** XDOT (M/S)	YDOT (M/S)	ZDOT (M/S)
NOMINAL	140.85	6430759.	55701.	103813.	892.04	257.19	2124.89
PRPT. LOADING MASS + LOX	.00	-208.	-0.	-150.	-3.78	-.01	-4.42
PRPT. LOADING MASS - LOX	.00	208.	-0.	150.	3.78	.00	4.44
PRPT. LOADING MASS + LH2	.00	-58.	-0.	-41.	-1.05	-.00	-1.23
PRPT. LOADING MASS - LH2	.00	58.	-0.	42.	1.05	-.00	1.23
NON-PROPELLANT MASS (+)	.00	-33.	0.	-24.	-.60	-.00	-.70
NON-PROPELLANT MASS (-)	.00	33.	0.	24.	.60	.00	.70
POSITIVE RSS	.00	219.	0.	158.	3.99	.00	4.66
NEGATIVE RSS	.00	-218.	-0.	-157.	-3.97	-.01	-4.64

TABLE 5 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT S-IB/S-IVB SEPARATION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	** EARTH FIXED POSITION VECTOR ** XE (M)	YE (M)	ZE (M)	** EARTH FIXED VELOCITY VECTOR ** XDOT (M/S)	YDOT (M/S)	ZDOT (M/S)
NOMINAL	140.85	58327.	-451.	66839.	913.03	-8.20	1808.04
PRPT. LOADING MASS + LOX	.00	-209.	1.	-14[illegible].	-3.82	-.00	-4.38
PRPT. LOADING MASS - LOX	.00	209.	-1.	149.	3.84	-.00	4.40
PRPT. LOADING MASS + LH2	.00	-58.	0.	-41.	-1.06	-.00	-1.21
PRPT. LOADING MASS - LH2	.00	58.	-0.	41.	1.06	-.00	1.22
NON-PROPELLANT MASS (+)	.00	-33.	0.	-24.	-.61	.00	-.70
NON-PROPELLANT MASS (-)	.00	33.	-0.	24.	.61	.00	.70
POSITIVE RSS	.00	220.	1.	156.	4.03	.00	4.62
NEGATIVE RSS	.00	-219.	-1.	-156.	-4.01	-.00	-4.60

TABLE 5 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT S-IB/S-IVB SEPARATION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	** VEHICLE ATTITUDE ** PITCH (DEG)	YAW (DEG)	ROLL (DEG)	** VEHICLE ATTITUDE RATE ** PITCH (DEG/S)	YAW (DEG/S)	ROLL (DEG/S)
NOMINAL	140.85	-64.008	-.096	.000	.006	-.023	-.000
PRPT. LOADING MASS + LOX	.00	.002	-.001	-.000	.002	-.001	-.000
PRPT. LOADING MASS - LOX	.00	-.00[illegible]	.001	.000	-.002	.001	.000
PRPT. LOADING MASS + LH2	.00	.00[illegible]	-.000	-.000	.000	-.000	-.000
PRPT. LOADING MASS - LH2	.00	-.001	.000	.000	-.000	.000	.000
NON-PROPELLANT MASS (+)	.00	.000	-.000	-.000	.000	-.000	-.000
NON-PROPELLANT MASS (-)	.00	-.000	.000	.000	-.000	.000	.000
POSITIVE RSS	.00	.002	.001	.000	.002	.001	.000
NEGATIVE RSS	.00	-.002	-.001	-.000	-.002	-.001	-.000

TABLE 5 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT S-IB/S-IVB SEPARATION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	GEODETIC LATITUDE (DEG)	LONGITUDE POSITIVE EAST (DEG)	EARTH FIXED VELOCITY (M/S)	EARTH FIXED PATH ANGLE (DEG)	ALTITUDE (M)	SPACE FIXED AZIMUTH (DEG)
NOMINAL	140.85	29.027	-80.115	2025.51	62.719	58675.	55.762
PRPT. LOADING MASS + LOX	.00	-.001	-.001	-5.64	.042	-210.	.014
PRPT. LOADING MASS - LOX	.00	.001	.001	5.66	-.042	211.	-.014
PRPT. LOADING MASS + LH2	.00	-.000	-.000	-1.56	.012	-58.	.004
PRPT. LOADING MASS - LH2	.00	.000	.000	1.57	-.012	58.	-.004
NON-PROPELLANT MASS (+)	.00	-.000	-.000	-.90	.007	-33.	.002
NON-PROPELLANT MASS (-)	.00	.000	.000	.90	-.007	33.	-.002
POSITIVE RSS	.00	.001	.001	5.94	.044	221.	.015
NEGATIVE RSS	.00	-.001	-.001	-5.92	-.044	-221.	-.015

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TABLE 6

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSION ENVELOPE AT S-IB/S-IVB SEPARATION
COMBINED S-IB AND S-IVB STAGE THREE-SIGMA DEVIATIONS

DISPERSION GROUP		FLIGHT TIME (SEC)	RADIUS (M)	SPACE FIXED VELOCITY (M/S)	SPACE FIXED PATH ANGLE (DEG)	GROUND RANGE (M)	EARTH FIXED CROSS RANGE (M)	VEHICLE WEIGHT (LB)
S-IB STAGE	+RSS	2.[illegible]2	2038.	45.73	1.871	4643.	4002.	3789.
S-IB STAGE	-RSS	[illegible]	2202.	41.42	1.775	3604.	2377.	2756.
S-IVB STAGE	+RSS	.[illegible]0	221.	5.80	.046	153.	1.	1322.
S-IVB STAGE	-RSS	.[illegible]0	221.	5.78	.048	152.	1.	1322.
COMBINED POSITIVE	RSS	2.[illegible]	2050.	4[illegible].10	1.872	4646.	4[illegible]2.	4013.
COMBINED NEGATIVE	RSS	2.[illegible]5	2303.	41.82	1.776	3607.	2377.	3057.

TABLE 6 (CONT'D)

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSION ENVELOPE AT S-IB/S-IVB SEPARATION
COMBINED S-IB AND S-IVB STAGE THREE-SIGMA DEVIATIONS

DISPERSION GROUP		FLIGHT TIME (SEC)	SPACE FIXED POSITION VECTOR XS (M)	YS (M)	ZS (M)	SPACE FIXED VELOCITY VECTOR XDOT (M/S)	YDOT (M/S)	ZDOT (M/S)
S-IB STAGE	+RSS	2.82	2072.	4065.	5204.	63.12	68.59	60.08
S-IB STAGE	-RSS	2.65	2339.	2473.	4266.	66.35	57.78	55.41
S-IVB STAGE	+RSS	.00	219.	0.	153.	3.99	.00	4.66
S-IVB STAGE	-RSS	.00	218.	0.	157.	3.97	.01	4.64
COMBINED POSITIVE	RSS	2.82	2084.	4065.	5206.	63.25	68.59	60.26
COMBINED NEGATIVE	RSS	2.65	2349.	2473.	4269.	66.47	57.78	55.60

TABLE 6 (CONT'D)

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSION ENVELOPE AT S-IB/S-IVB SEPARATION
COMBINED S-IB AND S-IVB STAGE THREE-SIGMA DEVIATIONS

DISPERSION GROUP		FLIGHT TIME (SEC)	EARTH FIXED POSITION VECTOR XL (M)	YE (M)	ZL (M)	EARTH FIXED VELOCITY VECTOR XDOT (M/S)	YDOT (M/S)	ZDOT (M/S)
S-IB STAGE	+RSS	[illegible].82	2051.	4002.	467[illegible].	62.56	68.61	60.34
S-IB STAGE	-RSS	[illegible].65	2311.	2377.	36[illegible].	65.74	57.77	55.65
S-IVB STAGE	+RSS	.00	220.	1.	15[illegible].	4.03	.00	4.62
S-IVB STAGE	-RSS	.00	219.	1.	156.	4.01	.00	4.60
COMBINED POSITIVE	RSS	[illegible].82	2063.	4002.	467[illegible].	62.69	68.61	60.52
COMBINED NEGATIVE	RSS	2.65	2321.	2377.	363[illegible].	65.86	57.77	55.84

TABLE 6 (CONT'D)

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSION ENVELOPE AT S-IB/S-IVB SEPARATIO
COMBINED S-IB AND S-IVB STAGE THREE-SIGMA DEVIATIONS

DISPERSION GROUP		FLIGHT TIME (SEC)	VEHICLE ATTITUDE PITCH (DEG)	YAW (DEG)	ROLL (DEG)
S-IB STAGE	+RSS	2.82	1.560	1.558	3.649
S-IB STAGE	-RSS	2.65	1.562	1.554	3.649
S-IVB STAGE	+RSS	.00	.002	.001	.000
S-IVB STAGE	-RSS	.00	.002	.001	.000
COMBINED POSITIVE	RSS	2.82	1.560	1.558	3.649
COMBINED NEGATIVE	RSS	2.65	1.562	1.554	3.649

TABLE 6 (CONT'D)

ASTF (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSION ENVELOPE AT S-IB/S-IVB SEPARATION
COMBINED S-IB AND S-IVB STAGE THREE-SIGMA DEVIATIONS

DISPERSION GROUP		FLIGHT TIME (SEC)	GEODETIC LATITUDE (DEG)	LONGITUDE POS. EAST (DEG)	EARTH FIXED VELOCITY (M/S)	EARTH FIXED PATH ANGLE (DEG)	ALTITUDE ( )	SPACE FIXED AZIMUTH (DEG)
S-IB STAGE	+RSS	2.82	.031	.045	43.22	2.171	2036.	1.839
S-IF STAGE	-RSS	2.65	.035	.031	40.03	2.059	22[illegible]8.	1.556
S-IVB STAGE	+RSS	.00	.001	.001	5.94	.044	221.	.015
S-IVB STAGE	-RSS	.00	.001	.001	5.92	.044	221.	.015
COMBINED POSITIVE	RSS	2.82	.031	.045	43.[illegible]	2.171	[illegible]8.	1.839
COMBINED NEGATIVE	RSS	2.65	.035	.031	40.47	2.053	2259.	1.556

TABLE 7

AS-210 (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	RADIUS (M)	SPACE FIXED VELOCITY (M/S)	SPACE FIXED FLIGHT PATH ANGLE (DEG)	ORBIT INCLINATION (DEG)	DESCENDING NODE ARGUMENT (DEG)	VEHICLE WEIGHT (LB)
NOMINAL	594.67	6528178.	7818.46	90.001	51.780	157.775	68340.
HIGH LOX DENSITY	-.61	-2.	.01	-.000	-.000	-.000	-49.
LOW LOX DENSITY	1.00	-2.	.00	.000	-.000	-.000	-5.
HIGH FUEL DENSITY	1.31	-4.	.03	-.000	-.000	-.000	-138.
LOW FUEL DENSITY	-.74	-0.	-.01	-.001	-.000	-.000	72.
PRPT. LOADING MASS + LOX	.01	6.	-.02	-.000	-.000	-.000	262.
PRPT. LOADING MASS - LOX	-.05	6.	.04	-.000	-.000	-.000	-366.
PRPT. LOADING MASS + RP-1	.44	-4.	.03	-.000	-.000	-.000	-199.
PRPT. LOADING MASS - RP-1	-.56	6.	-.02	-.000	-.000	-.000	173.
THRUST AND FLOWRATE (+)	-2.61	13.	-.06	-.000	-.000	-.000	329.
THRUST AND FLOWRATE (-)	3.05	-0.	.07	.000	-.000	-.000	-411.
ISP AND FLOWRATE (+,-)	.00	8.	-.01	-.000	-.000	-.000	419.
ISP AND FLOWRATE (-,+)	-.03	6.	.06	-.000	-.000	-.000	-420.
E.M.R. MAXIMUM RESIDUAL	.47	-5.	.06	-.000	-.000	-.000	-431.
E.M.R. MINIMUM RESIDUAL	-.29	3.	-.00	-.000	-.000	-.000	248.
H-1 ENGINE THRUST DECAY (+)	-.04	1.	.02	-.000	.000	.000	18.
H-1 ENGINE THRUST DECAY (-)	.04	-0.	.01	.000	.000	.000	-17.
NON-PROPELLANT MASS (+)	.08	-1.	.02	-.000	.000	.000	-37.
NON-PROPELLANT MASS (-)	-.08	1.	-.01	-.000	-.000	-.000	37.
THRUST MIS. + PITCH	.15	-5.	.05	-.000	-.000	-.000	-67.
THRUST MIS. - PITCH	.07	6.	-.02	-.000	.000	.000	-30.
THRUST MIS. + YAW	.09	-2.	.01	.000	.000	.000	-40.
THRUST MIS. - YAW	.18	-0.	.04	-.000	-.000	-.000	-82.
THRUST MIS. + ROLL	.00	1.	-.00	.000	-.000	-.000	-0.
THRUST MIS. - ROLL	.00	1.	-.00	.000	.000	.000	-0.
AXIAL FORCE COEF. (+)	1.00	4.	.05	-.000	-.000	-.000	-457.
AXIAL FORCE COEF. (-)	-.96	10.	-.06	-.000	-.000	-.000	437.
C.G. OFFSET (+Y)	-.01	1.	.00	.000	.000	.000	6.
C.G. OFFSET (-Y)	.03	0.	.02	.000	-.000	-.000	-15.
C.G. OFFSET (+Z)	.03	2.	.02	-.000	.000	.000	-13.
C.G. OFFSET (-Z)	-.01	-1.	.01	.000	-.000	-.000	6.
HEADWIND	.57	-4.	.03	-.000	-.000	-.000	-260.
TAILWIND	-1.21	-3.	-.04	-.000	-.000	-.000	555.
RIGHT CROSS WIND	.04	-1.	-.01	.000	.000	.000	-20.
LEFT CROSS WIND	.05	1.	.02	.000	-.000	-.000	-21.
HOT ATMOSPHERE PROFILE	.12	-1.	.01	.000	.000	.000	-53.
COLD ATMOSPHERE PROFILE	-.26	3.	-.01	-.000	-.000	-.000	117.
POSITIVE RSS	3.72	21.	.10	.000	.000	.000	981.
NEGATIVE RSS	-3.42	-11.	-.11	-.001	-.001	-.001	-1010.

TABLE 7 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	** SPACE FIXED POSITION VECTOR ** XS (M)	YS (M)	ZS (M)	** SPACE FIXED VELOCITY VECTOR ** XDOT (M/S)	YDOT (M/S)	ZDOT (M/S)
NOMINAL	594.07	6202530.	37898.	2035756.	-2422.78	-754.38	7395.23
HIGH LOX DENSITY	-.61	771.	240.	-2362.	2.90	.07	.96
LOW LOX DENSITY	1.00	-933.	-289.	2839.	-3.43	-.02	-1.12
HIGH FUEL DENSITY	1.31	-717.	-221.	2173.	-2.58	.03	-.61
LOW FUEL DENSITY	-.74	439.	137.	-1343.	1.68	.07	.55
PRPT. LOADING MASS + LOX	.01	-1001.	-311.	3070.	-3.65	.02	-1.22
PRPT. LOADING MASS - LOX	-.05	1443.	450.	-4393.	5.31	.05	1.79
PRPT. LOADING MASS + RP-1	.44	346.	109.	-1069.	1.31	.05	.46
PRPT. LOADING MASS - RP-1	-.56	-150.	-47.	476.	-.54	.02	-.20
THRUST AND FLOWRATE (+)	-2.61	1390.	430.	-4206.	5.14	.07	1.63
THRUST AND FLOWRATE (-)	3.05	-1303.	-403.	3974.	-4.83	-.01	-1.51
ISP AND FLOWRATE (+,-)	.00	-1519.	-472.	4658.	-5.55	.02	-1.86
ISP AND FLOWRATE (-,+)	-.03	1575.	491.	-4797.	5.79	.05	1.96
E.M.R. MAXIMUM RESIDUAL	.47	1175.	367.	-3608.	4.37	.06	1.50
E.M.R. MINIMUM RESIDUAL	-.29	-656.	-204.	2012.	-2.41	-.00	-.79
H-1 ENGINE THRUST DECAY (+)	-.04	-34.	-11.	107.	-.13	-.01	-.02
H-1 ENGINE THRUST DECAY (-)	.04	32.	10.	-97.	.11	-.00	.04
NON-PROPELLANT MASS (+)	.08	64.	20.	-197.	.23	-.01	.10
NON-PROPELLANT MASS (-)	-.08	-63.	-20.	197.	-.23	.00	-.09
THRUST MIS. + PITCH	.15	-2037.	-630.	6190.	-7.45	-.04	-2.39
THRUST MIS. - PITCH	.07	2068.	642.	-6305.	7.63	.04	2.47
THRUST MIS. + YAW	.09	-719.	-230.	2189.	-2.63	-.08	-.87
THRUST MIS. - YAW	.18	778.	249.	-2379.	2.85	.06	.98
THRUST MIS. + ROLL	.00	5.	1.	-13.	.01	.00	.00
THRUST MIS. - ROLL	.00	-4.	-1.	14.	-.02	-.00	-.01
AXIAL FORCE COEF. (+)	1.00	771.	241.	-2344.	2.82	.03	.98
AXIAL FORCE COEF. (-)	-.96	-713.	-223.	2207.	-2.59	.04	-.91
C.G. OFFSET (+Y)	-.01	-221.	-71.	679.	-.82	-.02	-.27
C.G. OFFSET (-Y)	.03	228.	72.	-695.	.80	.02	.26
C.G. OFFSET (+Z)	.03	585.	181.	-1779.	2.15	.00	.72
C.G. OFFSET (-Z)	-.01	-577.	-179.	1758.	-2.13	-.01	-.69
HEADWIND	.57	1262.	394.	-3870.	4.69	.07	1.57
TAILWIND	-1.21	-2742.	-850.	8341.	-9.98	.00	-3.32
RIGHT CROSS WIND	.04	-327.	-103.	996.	-1.21	-.02	-.41
LEFT CROSS WIND	.05	492.	159.	-1501.	1.40	.06	.61
HOT ATMOSPHERE PROFILE	.12	102.	32.	-315.	.35	-.00	.13
COLD ATMOSPHERE PROFILE	-.06	-182.	-57.	565.	-.67	.01	-.22
POSITIVE RSS	3.72	4067.	1266.	13654.	15.01	.20	4.99
NEGATIVE RSS	-3.42	-4480.	-1390.	-12383.	-16.37	-.10	-5.38

TABLE 7 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IB PROPULSION/NON PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	** EARTH FIXED POSITION VECTOR ** XE (M)	*YE (M)	ZE (M)	** EARTH FIXED VELOCITY VECTOR ** XDOT (M/S)	YDOT (M/S)	ZDOT (M/S)
NOMINAL	594.07	-114345.	-95690.	1865638.	-2136.37	-736.18	7180.02
HIGH LOX DENSITY	-.61	655.	294.	-2206.	2.63	-.31	.76
LOW LOX DENSITY	1.00	-770.	-406.	2573.	-3.02	.53	-.84
HIGH FUEL DENSITY	1.31	-546.	-420.	1808.	-2.09	.64	-.53
LOW FUEL DENSITY	-.74	340.	246.	-1136.	1.41	-.28	.38
PRPT. LOADING MASS + LOX	.01	-917.	-221.	3102.	-3.54	.24	-1.06
PRPT. LOADING MASS - LOX	-.05	1320.	330.	-4427.	5.15	-.28	1.55
PRPT. LOADING MASS + RP-1	.44	354.	-11.	-1210.	1.41	.12	.46
PRPT. LOADING MASS - RP-1	-.56	-185.	79.	648.	-.70	-.13	-.25
THRUST AND FLOWRATE (+)	-2.81	1036.	871.	-3417.	4.12	-1.19	1.05
THRUST AND FLOWRATE (-)	3.05	-934.	-898.	3111.	-3.74	1.32	-.91
ISP AND FLOWRATE (+,-)	.00	-1392.	-335.	4707.	-5.39	.35	-1.62
ISP AND FLOWRATE (-,+)	-.03	1442.	365.	-4841.	5.62	-.30	1.70
E.M.R. MAXIMUM RESIDUAL	.47	1117.	166.	-3787.	4.40	-.04	1.37
E.M.R. MINIMUM RESIDUAL	-.29	-626.	-87.	2120.	-2.43	.04	-.72
H-1 ENGINE THRUST DECAY (+)	-.04	-35.	0.	120.	-.14	-.01	-.02
H-1 ENGINE THRUST DECAY (-)	.04	32.	-0.	-109.	.11	.00	.04
NON-PROPELLANT MASS (+)	.08	65.	-2.	-223.	.25	.00	.10
NON-PROPELLANT MASS (-)	-.08	-65.	2.	223.	-.25	-.01	-.09
THRUST MIS. + PITCH	.15	-1856.	-476.	6215.	-7.19	.45	-2.05
THRUST MIS. - PITCH	.07	1902.	442.	-6394.	7.43	-.39	2.15
THRUST MIS. + YAW	.09	-652.	-183.	2187.	-2.53	.11	-.74
THRUST MIS. - YAW	.18	729.	142.	-2459.	2.83	-.05	.88
THRUST MIS. + ROLL	.00	5.	1.	-13.	.01	.00	.00
THRUST MIS. - ROLL	.00	-4.	-1.	14.	-.02	-.00	-.01
AXIAL FORCE COEF. (+)	1.00	793.	-30.	-2667.	3.06	.21	.99
AXIAL FORCE COEF. (-)	-.96	-735.	34.	2515.	-2.82	-.14	-.92
C.G. OFFSET (+Y)	-.01	-204.	-48.	690.	-.80	.02	-.24
C.G. OFFSET (-Y)	.03	212.	45.	-713.	.79	-.02	.25
C.G. OFFSET (+Z)	.03	539.	122.	-1807.	2.10	-.11	.63
C.G. OFFSET (-Z)	-.01	-531.	-124.	1781.	-2.07	.11	-.60
HEADWIND	.57	1206.	166.	-4082.	4.74	-.01	1.44
TAILWIND	-1.21	-2619.	-360.	8794.	-10.07	.18	-3.05
RIGHT CROSS WIND	.04	-296.	-63.	994.	-1.16	.06	-.35
LEFT CROSS WIND	.05	455.	105.	-1531.	1.76	-.04	.54
HOT ATMOSPHERE PROFILE	.12	104.	-1.	-352.	.38	.02	.13
COLD ATMOSPHERE PROFILE	-.26	-188.	11.	647.	-.73	-.04	-.23
POSITIVE RSS	3.72	3688.	1203.	13726.	14.44	1.71	4.30
NEGATIVE RSS	-3.42	-4086.	-1316.	-12397.	-15.81	-1.41	-4.65

* Earth fixed cross range

TABLE 7 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	** VEHICLE ATTITUDE ** PITCH (DEG)	YAW (DEG)	ROLL (DEG)	** VEHICLE ATTITUDE RATE ** PITCH (DEG/S)	YAW (DEG/S)	ROLL (DEG/S)
NOMINAL	594.07	-99.779	-13.741	.266	.000	-.001	.019
HIGH LOX DENSITY	-.61	.355	.007	.009	.001	-.008	-.030
LOW LOX DENSITY	1.00	-.450	.076	.157	.000	.000	-.011
HIGH FUEL DENSITY	1.31	-.501	.146	.341	.002	-.000	-.042
LOW FUEL DENSITY	-.74	.403	.002	.035	.000	-.000	.007
PRPT. LOADING MASS + LOX	.01	-.073	-.014	.114	.001	-.007	-.012
PRPT. LOADING MASS - LOX	-.05	.037	.020	.026	.001	-.009	-.028
PRPT. LOADING MASS + RP-1	.44	-.109	.081	-.230	-.000	-.001	-.006
PRPT. LOADING MASS - RP-1	-.56	.161	-.048	.347	.002	.000	-.043
THRUST AND FLOWRATE (+)	-2.81	1.230	-.219	.282	.002	.000	-.044
THRUST AND FLOWRATE (-)	3.05	-1.268	.254	-.916	-.001	-.001	.004
ISP AND FLOWRATE (+,-)	.00	-.021	-.009	.264	.002	.001	-.046
ISP AND FLOWRATE (-,+)	-.03	-.038	.022	-.037	-.000	-.001	-.009
E.M.R. MAXIMUM RESIDUAL	.47	-.104	.069	.236	.002	-.001	-.048
E.M.R. MINIMUM RESIDUAL	-.29	.093	-.018	-.053	-.000	-.000	-.004
H-1 ENGINE THRUST DECAY (+)	-.04	.011	-.003	.209	.003	.007	-.061
H-1 ENGINE THRUST DECAY (-)	.04	-.013	.003	-.117	-.000	-.000	-.009
NON-PROPELLANT MASS (+)	.08	-.026	.006	.221	-.001	.007	.016
NON-PROPELLANT MASS (-)	-.08	.029	-.007	.186	.002	.000	-.056
THRUST MIS. + PITCH	.15	-1.336	.179	-.104	-.000	-.001	.010
THRUST MIS. - PITCH	.07	1.26	-.159	.063	.001	-.007	-.012
THRUST MIS. + YAW	.09	-.153	-1.294	.061	.001	-.008	-.018
THRUST MIS. - YAW	.18	.098	1.331	.203	.002	-.000	-.054
THRUST MIS. + ROLL	.00	-.003	.016	-.024	.001	-.007	-.032
THRUST MIS. - ROLL	.00	-.000	-.017	.058	.000	.000	.016
AXIAL FORCE COEF. (+)	1.00	-.472	.100	.002	-.000	-.001	.015
AXIAL FORCE COEF. (-)	-.96	.409	-.080	-.019	-.000	.001	.008
C.G. OFFSET (+Y)	-.01	-.035	-.351	.311	.002	-.000	-.048
C.G. OFFSET (-Y)	.03	.029	.354	-1.023	-.001	-.000	.002
C.G. OFFSET (+Z)	.03	.329	-.050	.02[illegible]	-.001	.007	.026
C.G. OFFSET (-Z)	-.01	-.329	.050	-.004	-.000	.000	-.002
HEADWIND	.57	.131	.190	.005	.001	-.008	-.028
TAILWIND	-1.21	-.239	.165	.276	-.001	.008	.010
RIGHT CROSS WIND	.04	-.135	-.400	-.096	-.000	.000	-.009
LEFT CROSS WIND	.05	.003	1.220	.226	-.001	.008	.014
HOT ATMOSPHERE PROFILE	.12	-.040	.003	-.312	[illegible]	-.000	-.014
COLD ATMOSPHERE PROFILE	-.26	.118	-.010	[illegible]	[illegible]	-.007	-.023
POSITIVE RSS	3.72	* 1.939	* 1.890	* .920	.006	.017	.043
NEGATIVE RSS	-3.42	* -2.076	* -1.429	* -1.430	-.002	-.021	-.162

* Not applicable due to APS control limit of 1 degree error signal (see subsection 3.1).

TABLE 7 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	GEODETIC LATITUDE (DEG)	LONGITUDE POSITIVE EAST (DEG)	EARTH FIXED VELOCITY (M/S)	INERTIAL RANGE ANGLE (DEG)	GROUND RANGE (M)	ALTITUDE (M)
NOMINAL	594.07	9.453	-65.329	7527.20	18.279	1848850.	158604.
HIGH LOX DENSITY	-.61	-.013	-.020	.01	-.022	-2257.	-7.
LOW LOX DENSITY	1.00	.016	.023	.00	.026	2637.	4.
HIGH FUEL DENSITY	1.31	.012	.015	.03	.020	1861.	-0.
LOW FUEL DENSITY	-.74	-.008	-.010	-.01	-.012	-1169.	-3.
PRPT. LOADING MASS + LOX	.01	.017	.029	-.03	.028	3163.	12.
PRPT. LOADING MASS - LOX	-.05	-.025	-.042	.05	-.041	-4517.	-3.
PRPT. LOADING MASS + RP-1	.44	-.006	-.012	.03	-.010	-1228.	-6.
PRPT. LOADING MASS - RP-1	-.56	.003	.007	-.02	.004	653.	7.
THRUST AND FLOWRATE (+)	-2.81	-.024	-.029	-.05	-.039	-3521.	4.
THRUST AND FLOWRATE (-)	3.05	.022	.025	.06	.037	3209.	8.
ISP AND FLOWRATE (+,-)	.00	.026	.045	-.05	.043	48[illegible]0.	17.
ISP AND FLOWRATE (-,+)	-.03	-.027	-.046	.06	-.044	-4940.	-4.
E.M.R. MAXIMUM RESIDUAL	.47	-.020	-.036	.06	-.033	-3856.	-13.
E.M.R. MINIMUM RESIDUAL	-.29	.011	.020	-.00	.019	2159.	7.
H-1 ENGINE THRUST DECAY (+)	-.04	.001	.001	.02	.001	122.	1.
H-1 ENGINE THRUST DECAY (-)	.04	-.001	-.001	.01	-.001	-111.	-0.
NON-PROPELLANT MASS (+)	.08	-.001	-.002	.03	-.002	-226.	-1.
NON-PROPELLANT MASS (-)	-.08	.001	.002	-.01	.002	226.	2.
THRUST MIS. + PITCH	.15	.035	.059	.04	.057	6344.	7.
THRUST MIS. - PITCH	.07	-.035	-.061	-.01	-.058	-6522.	-7.
THRUST MIS. + YAW	.09	.012	.021	.00	.020	2233.	3.
THRUST MIS. - YAW	.18	-.013	-.023	.04	-.022	-2506.	-5.
THRUST MIS. + ROLL	.00	-.000	-.000	-.00	-.000	-13.	1.
THRUST MIS. - ROLL	.00	.000	.000	-.00	.000	14.	1.
AXIAL FORCE COEF. (+)	1.00	-.013	-.027	.06	-.022	-2710.	-1.
AXIAL FORCE COEF. (-)	-.96	.012	.025	-.06	.020	2552.	14.
C.G. OFFSET (+Y)	-.01	.004	.007	-.00	.006	703.	3.
C.G. OFFSET (-Y)	.03	-.004	-.007	.02	-.006	-727.	-1.
C.G. OFFSET (+Z)	.03	-.010	-.017	.02	-.016	-1844.	-1.
C.G. OFFSET (-Z)	-.01	.010	.017	.01	.016	1817.	2.
HEADWIND	.57	-.022	-.039	.03	-.036	-4155.	-12.
TAILWIND	-1.21	.047	.085	-.06	.077	8959.	14.
RIGHT CROSS WIND	.04	.006	.009	-.01	.009	1015.	1.
LEFT CROSS WIND	.05	-.008	-.015	.02	-.014	-1562.	-3.
HOT ATMOSPHERE PROFILE	.12	-.002	-.003	.01	-.003	-358.	-1.
COLD ATMOSPHERE PROFILE	-.26	.003	.006	-.01	.005	656.	4.
POSITIVE RSS	3.72	.076	.130	.16	.126	14007.	33.
NEGATIVE RSS	-3.42	-.069	-.117	-.12	-.114	-12650.	-22.

TABLE 7 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	APOGEE RADIUS (M)	PERIGEE RADIUS (M)	APOGEE VELOCITY (M/S)	PERIGEE VELOCITY (M/S)	SEMI-MAJOR AXIS (M)	SEMI-LATUS RECTUM (M)
NOMINAL	594.07	6543097.	6528129.	7800.63	7818.52	6535613.	6535605.
HIGH LOX DENSITY	-.61	-36.	49.	.05	-.05	6.	7.
LOW LOX DENSITY	1.00	4.	4.	-.00	-.00	4.	4.
HIGH FUEL DENSITY	1.31	84.	-1.	-.08	.03	41.	41.
LOW FUEL DENSITY	-.74	-98.	72.	.11	-.09	-13.	-13.
PRPT. LOADING MASS + LOX	.01	-71.	14.	.07	-.03	-29.	-28.
PRPT. LOADING MASS - LOX	-.05	166.	-3.	-.15	.05	81.	81.
PRPT. LOADING MASS + RP-1	.44	81.	-3.	-.07	.03	39.	39.
PRPT. LOADING MASS - RP-1	-.56	-112.	58.	.12	-.09	-27.	-27.
THRUST AND FLOWRATE (+)	-2.81	-191.	65.	.19	-.12	-63.	-63.
THRUST AND FLOWRATE (-)	3.05	242.	-10.	-.22	.08	116.	116.
ISP AND FLOWRATE (+,-)	.00	-140.	31.	.13	-.07	-55.	-54.
ISP AND FLOWRATE (-,+)	-.03	231.	-20.	-.21	.09	105.	105.
E.M.R. MAXIMUM RESIDUAL	.47	130.	45.	-.10	-.00	87.	87.
E.M.R. MINIMUM RESIDUAL	-.29	47.	-38.	-.05	.05	4.	4.
H-1 ENGINE THRUST DECAY (+)	-.04	37.	37.	-.02	-.02	37.	37.
H-1 ENGINE THRUST DECAY (-)	.04	14.	14.	-.01	-.01	14.	14.
NON-PROPELLANT MASS (+)	.08	82.	-2.	-.07	.03	40.	40.
NON-PROPELLANT MASS (-)	-.08	-17.	-17.	.01	.01	-17.	-17.
THRUST MIS. + PITCH	.15	117.	32.	-.09	.01	74.	74.
THRUST MIS. - PITCH	.07	-70.	15.	.07	-.03	-27.	-27.
THRUST MIS. + YAW	.09	48.	-36.	-.05	.05	6.	6.
THRUST MIS. - YAW	.18	102.	17.	-.09	.01	60.	60.
THRUST MIS. + ROLL	.00	-42.	43.	.05	-.05	0.	1.
THRUST MIS. - ROLL	.00	-1.	-1.	.00	.00	-1.	-1.
AXIAL FORCE COEF. (+)	1.00	224.	-28.	-.21	.09	98.	98.
AXIAL FORCE COEF. (-)	-.96	-240.	93.	.25	-.16	-78.	-78.
C.G. OFFSET (+Y)	-.01	2.	2.	-.00	-.00	2.	2.
C.G. OFFSET (-Y)	.03	74.	-11.	-.07	.03	32.	32.
C.G. OFFSET (+Z)	.03	32.	32.	-.02	-.02	32.	32.
C.G. OFFSET (-Z)	-.01	16.	16.	-.01	-.01	16.	16.
HEADWIND	.57	85.	1.	-.08	.02	43.	43.
TAILWIND	-1.21	-164.	7.	.15	-.05	-78.	-78.
RIGHT CROSS WIND	.04	-64.	21.	.06	-.04	-22.	-21.
LEFT CROSS WIND	.05	32.	32.	-.02	-.02	32.	32.
HOT ATMOSPHERE PROFILE	.12	19.	19.	-.01	-.01	19.	19.
COLD ATMOSPHERE PROFILE	-.76	-44.	41.	.05	-.05	-1.	-1.
POSITIVE RSS	3.72	517.	188.	.43	.18	263.	262.
NEGATIVE RSS	-3.42	-432.	-67.	-.46	-.27	-150.	-149.

TABLE 7 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	ORBIT ECCENTRICITY (-)	CONIC ENERGY (M2/SEC2)	ORBIT PERIOD (SEC)	ARGUMENT OF PERIGEE (DEG)	TRUE ANOMALY (DEG)	ECCENTRIC ANOMALY (DEG)
NOMINAL	594.07	.001145	-60089408.	5258.22	54.714	358.953	358.954
HIGH LOX DENSITY	-.61	-.000006	60.	.01	-.429	.408	.407
LOW LOX DENSITY	1.00	.000000	38.	.01	.123	-.096	-.096
HIGH FUEL DENSITY	1.31	.000006	387.	.05	-.291	.312	.312
LOW FUEL DENSITY	-.74	-.000013	-125.	-.02	-.460	.448	.448
PRPT. LOADING MASS + LOX	.01	-.000006	-268.	-.03	-.195	.223	.223
PRPT. LOADING MASS - LOX	-.05	.000013	762.	.10	-.319	.279	.278
PRPT. LOADING MASS + RP-1	.44	.000006	361.	.05	-.275	.266	.265
PRPT. LOADING MASS - RP-1	-.56	-.000013	-252.	-.03	-.142	.147	.146
THRUST AND FLOWRATE (+)	-2.81	-.000020	-587.	-.08	-.458	.419	.419
THRUST AND FLOWRATE (-)	3.05	.000019	1082.	.14	.235	-.198	-.198
ISP AND FLOWRATE (+,-)	.00	-.000013	-508.	-.07	-.196	.239	.239
ISP AND FLOWRATE (-,+)	-.03	.000019	984.	.13	-.303	.258	.258
E.M.R. MAXIMUM RESIDUAL	.47	.000006	815.	.11	-.388	.355	.354
E.M.R. MINIMUM RESIDUAL	-.29	.000006	41.	.01	-.065	.084	.084
H-1 ENGINE THRUST DECAY (+)	-.04	.000000	340.	.04	-.036	.037	.037
H-1 ENGINE THRUST DECAY (-)	.04	.000000	129.	.02	.055	-.056	-.056
NON-PROPELLANT MASS (+)	.08	.000006	373.	.05	-.010	.008	.008
NON-PROPELLANT MASS (-)	-.08	.000000	-159.	-.02	-.034	.035	.035
THRUST MIS. + PITCH	.15	.000006	694.	.09	-.081	.139	.139
THRUST MIS. - PITCH	.07	-.000006	-254.	-.03	-.290	.232	.231
THRUST MIS. + YAW	.09	.000006	56.	.01	.020	.000	.000
THRUST MIS. - YAW	.18	.000006	558.	.07	-.047	.025	.025
THRUST MIS. + ROLL	.00	-.000006	3.	.00	.065	-.065	-.065
THRUST MIS. - ROLL	.00	.000000	-10.	-.00	.010	-.010	-.010
AXIAL FORCE COEF. (+)	1.00	.000019	917.	.12	-.159	.138	.138
AXIAL FORCE COEF. (-)	-.96	-.000026	-730.	-.09	-.242	.263	.263
C.G. OFFSET (+Y)	-.01	.000000	22.	.00	.007	-.001	-.001
C.G. OFFSET (-Y)	.03	.000006	295.	.04	.194	-.201	-.200
C.G. OFFSET (+Z)	.03	.000000	301.	.04	-.118	.102	.101
C.G. OFFSET (-Z)	-.01	.000000	148.	.02	.059	-.043	-.043
HEADWIND	.57	.000006	402.	.05	-.374	.339	.338
TAILWIND	-1.21	-.000013	-730.	-.09	-.197	.274	.274
RIGHT CROSS WIND	.04	-.000006	-200.	-.03	.094	-.085	-.085
LEFT CROSS WIND	.05	.000000	295.	.04	-.008	-.006	-.006
HOT ATMOSPHERE PROFILE	.12	.000000	180.	.02	.160	-.163	-.163
COLD ATMOSPHERE PROFILE	-.26	-.000006	-13.	-.00	-.077	.083	.082
POSITIVE RSS	3.72	.000040	2453.	.32	.392	1.068	1.067
NEGATIVE RSS	-3.42	-.000045	-1396.	-.18	-1.155	-.363	-.362

ORIGINAL PAGE IS OF POOR QUALITY

TABLE 7 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	SPACE FIXED AZIMUTH (DEG)
NOMINAL	594.07	53.043
HIGH LOX DENSITY	-.61	-.014
LOW LOX DENSITY	1.00	.017
HIGH FUEL DENSITY	1.31	.014
LOW FUEL DENSITY	-.74	-.008
PRPT. LOADING MASS + LOX	.01	.019
PRPT. LOADING MASS - LOX	-.05	-.026
PRPT. LOADING MASS + RP-1	.44	-.006
PRPT. LOADING MASS - RP-1	-.56	.003
THRUST AND FLOWRATE (+)	-2.81	-.025
THRUST AND FLOWRATE (-)	3.05	.024
ISP AND FLOWRATE (+,-)	.00	.029
ISP AND FLOWRATE (-,+)	-.03	-.029
E.M.R. MAXIMUM RESIDUAL	.47	-.022
E.M.R. MINIMUM RESIDUAL	-.29	.012
H-1 ENGINE THRUST DECAY (+)	-.04	.001
H-1 ENGINE THRUST DECAY (-)	.04	-.001
NON-PROPELLANT MASS (+)	.08	-.001
NON-PROPELLANT MASS (-)	-.08	.001
THRUST MIS. + PITCH	.15	.038
THRUST MIS. - PITCH	.07	-.038
THRUST MIS. + YAW	.09	.013
THRUST MIS. - YAW	.18	-.014
THRUST MIS. + ROLL	.00	-.000
THRUST MIS. - ROLL	.00	.000
AXIAL FORCE COEF. (+)	1.00	-.014
AXIAL FORCE COEF. (-)	-.96	.014
C.G. OFFSET (+Y)	-.01	.004
C.G. OFFSET (-Y)	.03	-.004
C.G. OFFSET (+Z)	.03	-.011
C.G. OFFSET (-Z)	-.01	.011
HEADWIND	.57	-.023
TAILWIND	-1.21	.051
RIGHT CROSS WIND	.04	.006
LEFT CROSS WIND	.05	-.009
HOT ATMOSPHERE PROFILE	.12	-.002
COLD ATMOSPHERE PROFILE	-.26	.004
POSITIVE RSS	3.72	.083
NEGATIVE RSS	-3.42	-.074

TABLE 8

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	RADIUS (M)	SPACE FIXED VELOCITY (M/S)	SPACE FIXED FLIGHT PATH ANGLE (DEG)	ORBIT INCLINATION (DEG)	DESCENDING NODE ARGUMENT (DEG)	VEHICLE WEIGHT (LB)
NOMINAL	594.07	6528178.	7818.46	90.001	51.780	157.775	68340.
S-IVB PROPULSION CASE 1	-8.56	10.	.07	-.001	.001	.001	331.
S-IVB PROPULSION CASE 2	9.01	-6.	-.06	-.000	-.001	-.001	-370.
S-IVB PROPULSION CASE 3	-2.31	6.	-.01	-.000	-.000	-.000	547.
S-IVB PROPULSION CASE 4	2.37	-5.	.01	-.000	-.000	-.000	-543.
S-IVB PROPULSION CASE 5	-.90	9.	.00	-.000	-.000	-.000	12.
S-IVB PROPULSION CASE 6	.92	6.	-.00	-.000	-.000	-.000	-11.
S-IVB PROPULSION CASE 7	-3.31	3.	.07	-.000	.000	.000	88.
S-IVB PROPULSION CASE 8	3.39	-1.	-.01	.000	-.000	-.000	-90.
PRPT. LOADING MASS + LOX	2.64	5.	.01	-.000	-.000	-.000	73.
PRPT. LOADING MASS - LOX	-2.60	10.	.02	-.001	-.000	-.000	-55.
PRPT. LOADING MASS + LH2	.74	7.	.01	-.000	-.000	-.000	18.
PRPT. LOADING MASS - LH2	-.71	6.	.01	-.000	-.000	-.000	-16.
J-2 ENGINE THRUST DECAY (+)	.00	3.	2.04	-.002	.001	.002	1.
J-2 ENGINE THRUST DECAY (-)	.00	-3.	-2.04	.002	-.001	-.002	-1.
NON-PROPELLANT MASS (+)	.42	-3.	-.00	-.000	-.000	-.000	10.
NON-PROPELLANT MASS (-)	-.42	4.	.02	-.000	-.000	-.000	-10.
THRUST MIS. + PITCH	.10	-3.	.02	-.000	.000	.000	-46.
THRUST MIS. - PITCH	-.03	7.	.00	-.001	-.000	-.000	15.
THRUST MIS. + YAW	.01	-1.	-.01	-.000	.000	.000	-4.
THRUST MIS. - YAW	.06	1.	.02	.000	-.000	-.000	-26.
C.G. OFFSET (+Y)	-.01	1.	.00	-.000	-.001	-.002	3.
C.G. OFFSET (-Y)	.02	-0.	.02	.000	.002	.002	-8.
C.G. OFFSET (+Z)	-.02	-13.	.00	.002	-.000	-.000	11.
C.G. OFFSET (-Z)	.04	17.	.01	-.002	.000	.000	-17.
POSITIVE RSS	10.34	27.	2.04	.003	.002	.004	650.
NEGATIVE RSS	-9.89	-16.	-2.04	-.004	-.002	-.004	-668.

TABLE 8 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	** SPACE FIXED POSITION VECTOR ** XS (M)	YS (M)	ZS (M)	** SPACE FIXED VELOCITY VECTOR ** XDOT (M/S)	YDOT (M/S)	ZDOT (M/S)
NOMINAL	594.07	6202530.	37898.	2035756.	-2422.76	-754.38	7395.23
S-IVB PROPULSION CASE 1	-8.56	10877.	3392.	-33479.	40.33	.11	13.17
S-IVB PROPULSION CASE 2	9.01	-11578.	-3558.	34987.	-42.01	-.09	-13.97
S-IVB PROPULSION CASE 3	-2.31	2527.	785.	-7710.	9.32	.07	3.05
S-IVB PROPULSION CASE 4	2.37	-2595.	-803.	7887.	-9.45	.01	-3.09
S-IVB PROPULSION CASE 5	-.90	1176.	365.	-3567.	4.33	.06	1.43
S-IVB PROPULSION CASE 6	.92	-1200.	-372.	3679.	-4.40	.03	-1.44
S-IVB PROPULSION CASE 7	-3.31	4254.	1321.	-13024.	15.68	.04	5.15
S-IVB PROPULSION CASE 8	3.39	-4381.	-1353.	13321.	-16.[illegible]3	-.04	-5.29
PRPT. LOADING MASS + LOX	2.64	-2628.	-813.	8020.	-9.64	.01	-3.16
PRPT. LOADING MASS - LOX	-2.60	2604.	808.	-7935.	9.61	.06	3.17
PRPT. LOADING MASS + LH2	.74	-734.	-227.	2263.	-2.68	.03	-.87
PRPT. LOADING MASS - LH2	-.71	714.	221.	-2161.	2.64	.04	.87
J-2 ENGINE THRUST DECAY (+)	.00	-3.	-5.	19.	-.34	-.51	1.99
J-2 ENGINE THRUST DECAY (-)	.00	3.	5.	-19.	.34	.50	-1.99
NON-PROPELLANT MASS (+)	.42	-418.	-129.	1265.	-1.51	.05	-.49
NON-PROPELLANT MASS (-)	-.42	419.	130.	-1265.	1.54	.02	.53
THRUST MIS. + PITCH	.10	-589.	-182.	1786.	-2.15	-.05	-.69
THRUST MIS. - PITCH	-.03	603.	186.	-1820.	2.26	.08	.75
THRUST MIS. + YAW	.01	-214.	-70.	650.	-.73	-.06	-.26
THRUST MIS. - YAW	.06	227.	74.	-692.	.78	.03	.28
C.G. OFFSET (+Y)	-.01	-90.	-11.	278.	-.33	.31	-.07
C.G. OFFSET (-Y)	.02	92.	11.	-284.	.32	-.33	.10
C.G. OFFSET (+Z)	-.02	246.	81.	-793.	.71	.05	.24
C.G. OFFSET (-Z)	.04	-240.	-80.	786.	-.63	-.04	-.20
POSITIVE RSS	10.34	12334.	3842.	39403.	45.68	.62	15.07
NEGATIVE RSS	-9.89	-13019.	-4006.	-37899.	-47.32	-.62	-15.82

TABLE 8 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	** EARTH FIXED POSITION VECTOR ** XE (M)	*YE (M)	ZE ** (M)	** EARTH FIXED VELOCITY VECTOR ** XDOT (M/S)	YDOT (M/S)	ZDOT ** (M/S)
NOMINAL	594.07	-114345.	-95690.	1865636.	-2136.37	-736.18	7180.02
S-IVB PROPULSION CASE 1	-8.56	9247.	4136.	-31297.	36.49	-5.19	10.35
S-IVB PROPULSION CASE 2	9.01	-9844.	-4314.	32707.	-38.00	5.50	-10.97
S-IVB PROPULSION CASE 3	-2.31	2121.	1021.	-7116.	8.34	-1.27	2.35
S-IVB PROPULSION CASE 4	2.37	-2178.	-1043.	7273.	-8.44	1.38	-2.38
S-IVB PROPULSION CASE 5	-.90	1003.	439.	-3341.	3.93	-.50	1.12
S-IVB PROPULSION CASE 6	.92	-1021.	-448.	3445.	-3.99	.61	-1.14
S-IVB PROPULSION CASE 7	-3.31	3620.	1601.	-12186.	14.20	-2.01	4.05
S-IVB PROPULSION CASE 8	3.39	-3727.	-1637.	12462.	-14.51	2.07	-4.16
PRPT. LOADING MASS + LOX	2.64	-2184.	-1104.	7326.	-8.54	1.48	-2.40
PRPT. LOADING MASS - LOX	-2.60	2167.	1095.	-7251.	8.53	-1.39	2.42
PRPT. LOADING MASS + LH2	.74	-609.	-309.	2068.	-2.37	.45	-.66
PRPT. LOADING MASS - LH2	-.71	595.	300.	-1974.	2.34	-.36	.67
J-2 ENGINE THRUST DECAY (+)	.00	-3.	-4.	19.	-.30	-.46	2.01
J-2 ENGINE THRUST DECAY (-)	.00	3.	4.	-19.	.30	.45	-2.01
NON-PROPELLANT MASS (+)	.42	-348.	-175.	1155.	-1.33	.28	-.37
NON-PROPELLANT MASS (-)	-.42	349.	175.	-1156.	1.37	-.22	.41
THRUST MIS. + PITCH	.10	-532.	-149.	1776.	-2.06	.12	-.58
THRUST MIS. - PITCH	-.03	551.	138.	-1831.	2.19	-.07	.65
THRUST MIS. + YAW	.01	-195.	-52.	655.	-.70	-.01	-.22
THRUST MIS. - YAW	.06	213.	42.	-716.	.78	-.00	.25
C.G. OFFSET (+Y)	-.01	-83.	-2.	282.	-.31	.33	-.07
C.G. OFFSET (-Y)	.02	86.	-1.	-292.	.30	-.34	.09
C.G. OFFSET (+Z)	-.02	222.	63.	-794.	.67	-.01	.20
C.G. OFFSET (-Z)	.04	-215.	-65.	783.	-.59	.03	-.17
POSITIVE RSS	10.34	10474.	4717.	36786.	41.28	6.29	11.89
NEGATIVE RSS	-9.89	-11055.	-4894.	-35385.	-42.74	-5.94	-12.47

* Earth fixed cross range.

TABLE 8 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	** VEHICLE ATTITUDE ** PITCH (DEG)	YAW (DEG)	ROLL (DEG)	** VEHICLE ATTITUDE RATE ** PITCH (DEG/S)	YAW (DEG/S)	ROLL (DEG/S)
NOMINAL	594.07	-99.779	-13.741	.266	.000	-.001	.019
S-IVB PROPULSION CASE 1	-8.56	.793	-1.346	-.078	-.000	-.001	.014
S-IVB PROPULSION CASE 2	9.01	-.789	1.263	-.025	-.000	.001	.013
S-IVB PROPULSION CASE 3	-2.31	.152	-.301	.013	-.000	.001	.012
S-IVB PROPULSION CASE 4	2.37	-.100	.341	.021	-.000	-.001	.014
S-IVB PROPULSION CASE 5	-.90	.056	-.128	.097	.000	-.007	-.015
S-IVB PROPULSION CASE 6	.92	-.125	.146	-.146	-.001	-.000	-.009
S-IVB PROPULSION CASE 7	-3.31	.312	-.500	-.157	-.001	-.000	-.008
S-IVB PROPULSION CASE 8	3.39	-.317	.491	.282	-.001	.008	.014
PRPT. LOADING MASS + LOX	2.64	-.363	.366	-.326	-.001	.000	-.015
PRPT. LOADING MASS - LOX	-2.60	.295	-.355	.044	-.001	.007	.025
PRPT. LOADING MASS + LH2	.74	-.128	.111	.003	-.000	.000	.014
PRPT. LOADING MASS - LH2	-.71	.071	-.094	.041	.004	-.008	-.019
J-2 ENGINE THRUST DECAY (+)	.00	.000	.000	-.006	-.001	.036	-.041
J-2 ENGINE THRUST DECAY (-)	.00	.000	.000	-.000	.002	.028	-.049
NON-PROPELLANT MASS (+)	.42	.023	.098	-1.256	.001	.008	-.051
NON-PROPELLANT MASS (-)	-.42	.039	-.055	.061	.001	-.008	-.023
THRUST MIS. + PITCH	.10	-.678	.053	-.376	.031	.007	.039
THRUST MIS. - PITCH	-.03	.652	-.053	.675	-.028	-.009	-.037
THRUST MIS. + YAW	.01	-.058	-.591	.012	-.001	.129	-.021
THRUST MIS. - YAW	.06	.063	.599	-.066	.001	.063	-.021
C.G. OFFSET (+Y)	-.01	-.022	-.024	.096	.001	.018	-.010
C.G. OFFSET (-Y)	.02	.024	.025	-.927	.000	.028	-.041
C.G. OFFSET (+Z)	-.02	.026	-.030	.314	.037	.001	-.011
C.G. OFFSET (-Z)	.04	-.044	.024	.016	-.035	-.000	-.063
POSITIVE RSS	10.34	* 1.130	* 1.579	* .812	.049	.138	.054
NEGATIVE RSS	-9.69	-1.167	-1.631	* -1.654	-.045	-.016	-.116

* Not applicable due to APS control limit of 1 degree error signal (see subsection 3.1).

TABLE 8 (CONT'D)

AS-210 (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	GEODETIC LATITUDE (DEG)	LONGITUDE POSITIVE EAST (DEG)	EARTH FIXED VELOCITY (M/S)	INERTIAL RANGE ANGLE (DEG)	GROUND RANGE (M)	ALTITUDE (M)
NOMINAL	594.07	39.453	-65.329	7527.20	18.279	1848850.	158604.
S-IVB PROPULSION CASE 1	-8.56	-.187	-.284	.12	-.309	-32001.	-58.
S-IVB PROPULSION CASE 2	9.01	.195	.299	-.12	.323	33495.	65.
S-IVB PROPULSION CASE 3	-2.31	-.043	-.064	.01	-.071	-7279.	-9.
S-IVB PROPULSION CASE 4	2.37	.044	.066	-.00	.073	7449.	11.
S-IVB PROPULSION CASE 5	-.90	-.020	-.030	.01	-.033	-3420.	1.
S-IVB PROPULSION CASE 6	.92	.021	.031	-.01	.034	3523.	14.
S-IVB PROPULSION CASE 7	-3.31	-.073	-.111	.05	-.120	-12464.	-23.
S-IVB PROPULSION CASE 8	3.39	.074	.114	-.03	.123	12755.	26.
PRPT. LOADING MASS + LOX	2.64	.045	.066	-.00	.074	7503.	21.
PRPT. LOADING MASS - LOX	-2.60	-.044	-.065	.03	-.073	-7427.	-6.
PRPT. LOADING MASS + LH2	.74	.013	.019	.00	.021	2116.	12.
PRPT. LOADING MASS - LH2	-.71	-.012	-.018	.01	-.020	-2023.	2.
J-2 ENGINE THRUST DECAY (+)	.00	.000	.000	2.04	.000	19.	3.
J-2 ENGINE THRUST DECAY (-)	.00	-.000	-.000	-2.04	-.000	-19.	-3.
NON-PROPELLANT MASS (+)	.42	.007	.010	-.01	.012	1184.	-1.
NON-PROPELLANT MASS (-)	-.42	-.007	-.010	.02	-.012	-1185.	1.
THRUST MIS. + PITCH	.10	.010	.017	.02	.016	1814.	0.
THRUST MIS. - PITCH	-.03	-.010	-.017	.00	-.017	-1870.	3.
THRUST MIS. + YAW	.01	.004	.006	-.01	.006	668.	1.
THRUST MIS. - YAW	.06	-.004	-.007	.02	-.006	-730.	-1.
C.G. OFFSET (+Y)	-.01	.001	.003	-.01	.003	286.	1.
C.G. OFFSET (-Y)	.02	-.001	-.003	.04	-.003	-296.	-1.
C.G. OFFSET (+Z)	-.02	-.004	-.007	.00	-.007	-807.	-15.
C.G. OFFSET (-Z)	.04	.004	.007	.01	.007	795.	18.
POSITIVE RSS	10.34	.220	.336	2.05	.364	37671.	79.
NEGATIVE RSS	-9.89	-.212	-.321	-2.05	-.349	-36187.	-66.

TABLE 8 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	APOGEE RADIUS (M)	PERIGEE RADIUS (M)	APOGEE VELOCITY (M/S)	PERIGEE VELOCITY (M/S)	SEMI-MAJOR AXIS (M)	SEMI-LATUS RECTUM (M)
NOMINAL	594.07	6543097.	6528129.	7800.63	7818.52	6535613.	6535605.
S-IVB PROPULSION CASE 1	-8.56	260.	8.	-.23	.07	134.	134.
S-IVB PROPULSION CASE 2	9.01	-244.	12.	.22	-.08	-116.	-116.
S-IVB PROPULSION CASE 3	-2.31	-38.	47.	.05	-.05	4.	4.
S-IVB PROPULSION CASE 4	2.37	-36.	49.	.15	-.05	7.	7.
S-IVB PROPULSION CASE 5	-.90	64.	-20.	-.06	.04	22.	22.
S-IVB PROPULSION CASE 6	.92	-35.	50.	.05	-.06	7.	7.
S-IVB PROPULSION CASE 7	-3.31	97.	13.	-.08	.02	55.	55.
S-IVB PROPULSION CASE 8	3.39	-65.	20.	.06	-.04	-23.	-22.
PRPT. LOADING MASS + LOX	2.64	25.	25.	-.01	-.01	25.	25.
PRPT. LOADING MASS - LOX	-2.60	53.	53.	-.03	-.03	53.	53.
PRPT. LOADING MASS + LH2	.74	25.	25.	-.01	-.01	25.	25.
PRPT. LOADING MASS - LH2	-.71	21.	21.	-.01	-.01	21.	21.
J-2 ENGINE THRUST DECAY (+)	.00	6778.	59.	-6.04	1.97	3418.	3409.
J-2 ENGINE THRUST DECAY (-)	.00	-6874.	47.	6.17	-2.09	-3414.	-3408.
NON-PROPELLANT MASS (+)	.42	-11.	-11.	.01	.01	-11.	-11.
NON-PROPELLANT MASS (-)	-.42	90.	6.	-.08	.02	48.	48.
THRUST MIS. + PITCH	.10	29.	29.	-.02	-.02	29.	29.
THRUST MIS. - PITCH	-.03	16.	16.	-.01	-.01	16.	16.
THRUST MIS. + YAW	.01	-63.	22.	.06	-.04	-20.	-20.
THRUST MIS. - YAW	.06	34.	34.	-.12	-.02	34.	34.
C.G. OFFSET (+Y)	-.01	-35.	50.	.05	-.06	7.	7.
C.G. OFFSET (-Y)	.02	82.	-3.	-.07	.03	39.	39.
C.G. OFFSET (+Z)	-.02	-26.	-26.	.12	.02	-26.	-26.
C.G. OFFSET (-Z)	.04	86.	2.	-.08	.02	44.	44.
POSITIVE RSS	10.34	6786.	129.	6.17	1.97	3423.	3414.
NEGATIVE RSS	-9.89	-6880.	-35.	-6.05	-2.10	-3416.	-3410.

TABLE 8 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	ORBIT ECCENTRICITY (-)	CONIC ENERGY (M2/SEC2)	ORBIT PERIOD (SEC)	ARGUMENT OF PERIGEE (DEG)	TRUE ANOMALY (DEG)	ECCENTRIC ANOMALY (DEG)
NOMINAL	594.07	.001145	-60989408.	5258.22	54.714	356.953	356.954
S-IVB PROPULSION CASE 1	-8.56	.000019	1253.	.16	-.804	.493	.493
S-IVB PROPULSION CASE 2	9.01	-.000020	-1083.	-.14	-.090	.416	.415
S-IVB PROPULSION CASE 3	-2.31	-.000006	39.	.01	-.381	.309	.309
S-IVB PROPULSION CASE 4	2.37	-.000006	63.	.01	-.235	.308	.308
S-IVB PROPULSION CASE 5	-.90	.000006	205.	.03	-.319	.286	.285
S-IVB PROPULSION CASE 6	.92	-.000006	67.	.01	-.108	.142	.142
S-IVB PROPULSION CASE 7	-3.31	.000006	515.	.07	-.285	.164	.164
S-IVB PROPULSION CASE 8	3.39	-.000006	-211.	-.03	.191	-.068	-.067
PRPT. LOADING MASS + LOX	2.64	.000000	229.	.03	.028	.047	.047
PRPT. LOADING MASS - LOX	-2.60	.000000	491.	.06	-.563	.489	.489
PRPT. LOADING MASS + LH2	.74	.000000	232.	.03	-.239	.260	.260
PRPT. LOADING MASS - LH2	-.71	.000000	196.	.03	-.286	.266	.265
J-2 ENGINE THRUST DECAY (+)	.00	.000513	31883.	4.13	-1.690	1.689	1.687
J-2 ENGINE THRUST DECAY (-)	.00	-.000529	-31875.	-4.12	4.539	-4.538	-4.536
NON-PROPELLANT MASS (+)	.42	.000000	-104.	-.01	-.106	.118	.118
NON-PROPELLANT MASS (-)	-.42	.000006	445.	.06	-.166	.154	.154
THRUST MIS. + PITCH	.10	.000000	268.	.03	-.019	.036	.036
THRUST MIS. - PITCH	-.03	.000000	148.	.02	-.488	.471	.471
THRUST MIS. + YAW	.01	-.000006	-187.	-.02	-.323	.329	.329
THRUST MIS. - YAW	.06	.000000	317.	.04	.295	-.301	-.301
C.G. OFFSET (+Y)	-.01	-.000006	68.	.01	-.082	.086	.085
C.G. OFFSET (-Y)	.02	.000006	369.	.05	.164	-.169	-.168
C.G. OFFSET (+Z)	-.02	.000000	-239.	-.03	1.630	-1.638	-1.636
C.G. OFFSET (-Z)	.04	.000006	412.	.05	-2.069	2.076	2.074
POSITIVE RSS	10.34	.000514	31928.	4.13	4.839	2.878	2.874
NEGATIVE RSS	-9.89	-.000530	-31896.	-4.12	-2.981	-4.837	-4.834

TABLE 8 (CONT'D)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSIONS AT ORBIT INSERTION
S-IVB PROPULSION/NON-PROPULSION THREE SIGMA DEVIATIONS

VARIATIONS	FLIGHT TIME (SEC)	SPACE FIXED AZIMUTH (DEG)
NOMINAL	594.07	53.043
S-IVB PROPULSION CASE 1	-8.56	-.203
S-IVB PROPULSION CASE 2	9.01	.214
S-IVB PROPULSION CASE 3	-2.31	-.047
S-IVB PROPULSION CASE 4	2.37	.048
S-IVB PROPULSION CASE 5	-.90	-.021
S-IVB PROPULSION CASE 6	.92	.023
S-IVB PROPULSION CASE 7	-3.31	-.079
S-IVB PROPULSION CASE 8	3.39	.081
PRPT. LOADING MASS + LOX	2.64	.049
PRPT. LOADING MASS - LOX	-2.60	-.048
PRPT. LOADING MASS + LH2	.74	.014
PRPT. LOADING MASS - LH2	-.71	-.013
J-2 ENGINE THRUST DECAY (+)	.00	-.002
J-2 ENGINE THRUST DECAY (-)	.00	.002
NON-PROPELLANT MASS (+)	.42	.008
NON-PROPELLANT MASS (-)	-.42	-.008
THRUST MIS. + PITCH	.10	.011
THRUST MIS. - PITCH	-.03	-.011
THRUST MIS. + YAW	.01	.003
THRUST MIS. - YAW	.06	-.004
C.G. OFFSET (+Y)	-.01	.004
C.G. OFFSET (-Y)	.02	-.004
C.G. OFFSET (+Z)	-.02	-.004
C.G. OFFSET (-Z)	.04	.004
POSITIVE RSS	10.34	.241
NEGATIVE RSS	-9.89	-.230

TABLE 9

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSION ENVELOPE AT ORBIT INSERTION
COMBINED S-IB, S-IVB STAGE AND IMU THREE-SIGMA DEVIATIONS

DISPERSION GROUP		FLIGHT TIME (SEC)	RADIUS (M)	SPACE VELOCITY (M/S)	FIXED FLIGHT PATH ANGLE (DEG)	ORBITAL INCLIN. (DEG)	DESC. NODE ARGUMENT (DFG)	VEHICLE WEIGHT (LB)
S-IB STAGE	+RSS	3.72	21.	.16	.000	.000	.000	981.
S-IB STAGE	-RSS	3.42	11.	.11	.001	.001	.001	1010.
S-IVB STAGE	+RSS	10.34	27.	2.04	.003	.002	.004	650.
S-IVB STAGE	-RSS	9.49	16.	2.04	.004	.002	.004	668.
IMU	+RSS	.05	504.	1.38	.018	.019	.019	22.
IMU	-RSS	.05	502.	1.37	.018	.019	.019	21.
COMBINED POSITIVE	RSS	10.99	505.	2.47	.018	.019	.019	1177.
COMBINED NEGATIVE	RSS	10.46	502.	2.46	.018	.019	.019	1211.

TABLE 9 (CONT'D)

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSION ENVELOPE AT ORBIT INSERTION
COMBINED S-IB, S-IVB STAGE AND IMU THREE-SIGMA DEVIATION

DISPERSION GROUP		FLIGHT TIME (SEC)	SPACE FIXED POSITION VECTOR XS (M)	YS (M)	ZS (M)	SPACE FIXED VELOCITY VECTOR XDOT (M/S)	YDOT (M/S)	ZDOT (M/S)
S-IB STAGE	+RSS	[illegible].72	4063.	1266.	13654.	15.01	.20	4.99
S-IB STAGE	-RSS	3.42	4480.	1390.	1238[illegible].	16.37	.10	5.38
S-IVB STAGE	+RSS	1[illegible].34	12334.	3842.	3940[illegible].	45.68	.[illegible]2	15.07
S-IVB STAGE	-RSS	9.89	13019.	4006.	3789[illegible].	47.32	.[illegible]2	15.82
IMU	+RSS	.05	559.	763.	31[illegible].	2.77	3.14	1.11
IMU	-RSS	.05	555.	762.	321.	2.81	3.14	1.1[illegible]
COMBINED POSITIVE	RSS	1[illegible].99	12997.	4117.	4170[illegible].	48.16	3.21	15.91
COMBINED NEGATIVE	RSS	1[illegible].45	13779.	4308.	39874.	50.15	3.20	16.75

TABLE [illegible] (CONT'D)

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSION ENVELOPE AT ORBIT INSERTION
COMBINED S-IB, S-IVB STAGE AND IMU THREE-SIGMA DEVIATIONS

DISPERSION GROUP		FLIGHT TIME (SEC)	EARTH FIXED POSITION VECTOR XE (M)	* YE (M)	ZE (M)	EARTH FIXED VELOCITY VECTOR XDOT (M/S)	YDOT (M/S)	ZDOT (M/S)
S-IB STAGE	+RSS	3.72	3688.	1203.	1372[illegible].	14.44	1.71	4.30
S-IB STAGE	-RSS	3.42	4086.	1316.	12397.	15.81	1.41	4.65
S-IVB STAGE	+RSS	1[illegible].34	10474.	4717.	367[illegible].	41.28	6.29	11.89
S-IVB STAGE	-RSS	[illegible].89	11055.	4894.	353[illegible].	42.74	5.[illegible]4	12.47
IMU	+RSS	.05	539.	764.	30[illegible].	2.77	3.15	1.10
IMU	-RSS	.05	535.	764.	31[illegible].	2.81	3.15	1.09
COMBINED POSITIVE	RSS	1[illegible].99	11117.	4928.	39267.	43.82	7.[illegible]4	12.69
COMBINED NEGATIVE	RSS	1[illegible].46	11798.	5125.	3749[illegible].	45.66	6.[illegible]7	13.35

* Earth fixed cross range.

TABLE 9 (CONT'D)

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSION ENVELOPE AT ORBIT INSERTION
COMBINED S-IB, S-IVB STAGE AND IMU THREE-SIGMA DEVIATION

DISPERSION GROUP		FLIGHT TIME (SEC)	GEODETIC LATITUDE (DEG)	LONGITUDE POS. EAST (DEG)	EARTH FIXED VELOCITY (M/S)	INERTIAL RANGE ANGLE (DEG)	GROUND RANGE (M)	ALTITUDE (M)
S-IB STAGE	+RSS	3.72	.076	.130	.16	.126	14007.	33.
S-IB STAGE	-RSS	3.42	.069	.117	.12	.114	12650.	22.
S-IVB STAGE	+RSS	10.34	.220	.336	[illegible]	.364	37671.	79.
S-IVB STAGE	-RSS	9.[illegible]	.212	.321	2.05	.349	36187.	[illegible]6.
IMU	+RSS	.05	.006	.006	1.39	.003	344.	5[illegible]4.
IMU	-RSS	.05	.006	.006	1.3[illegible]	.003	350.	5[illegible]1.
COMBINED POSITIVE	RSS	10.99	.233	.360	2.46	.3[illegible]	[illegible]6192.	511.
COMBINED NEGATIVE	RSS	10.46	.223	.342	2.47	.367	[illegible]8336.	566.

TABLE [illegible] (CONT'D)

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSION ENVELOPE AT ORBIT INSERTION
COMBINED S-IB, S-IVB STAGE AND IMU THREE-SIGMA DEVIATIONS

DISPERSION GROUP		FLIGHT TIME (SEC)	APOGEE RADIUS (M)	PERIGEE RADIUS (M)	APOGEE VELOCITY (M/S)	PERIGEE VELOCITY (M/S)	SEMI-MAJOR AXIS (M)	SEMI-LATUS AXIS (M)
S-IB STAGE	+RSS	3.72	517.	188.	.43	.18	263.	262.
S-IB STAGE	-RSS	3.42	432.	67.	.46	.27	15[illegible].	149.
S-IVB STAGE	+RSS	10.3[illegible]	6786.	129.	[illegible].17	1.97	[illegible]423.	3414.
S-IVB STAGE	-RSS	9.89	6880.	35.	[illegible].05	2.10	3416.	3410.
IMU	+RSS	.05	4068.	589.	3.60	1.44	2005.	2000.
IMU	-RSS	.05	3989.	636.	[illegible].68	1.[illegible]7	1967.	1962.
COMBINED POSITIVE	RSS	10.99	7929.	632.	7.16	2.45	397[illegible].	3965.
COMBINED NEGATIVE	RSS	10.4[illegible]	7964.	640.	[illegible].10	2.52	3945.	3937.

TABLE [illegible] (CONT'D)

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSION ENVELOPE AT ORBIT INSERTION
COMBINED S-IB, S-IVB STAGE AND IMU THREE-SIGMA DEVIATIONS

DISPERSION GROUP		FLIGHT TIME (SEC)	ORBIT ECCENTRICITY	CONIC ENERGY (M2/SEC)	ORBIT PERIOD (SEC)	ARGUMENT OF PERIGEE (DEG)	TRUE ANOMALY (DEG)	ECCENTRIC ANOMALY (DEG)
S-IB STAGE	+RSS	3.7[illegible]	.000040	2453.	.32	.392	1.068	1.067
S-IB STAGE	-RSS	3.42	.000045	1396.	.18	1.155	.363	.362
S-IVB STAGE	+RSS	10.34	.000514	31928.	4.13	4.839	2.878	2.874
S-IVB STAGE	-RSS	9.89	.000530	31896.	4.12	[illegible].961	4.837	4.834
IMU	+RSS	.05	.000323	18704.	2.42	15.156	16.374	16.356
IMU	-RSS	.05	.000315	18355.	2.[illegible]7	16.375	15.158	15.140
COMBINED POSITIVE	RSS	10.99	.000608	37084.	4.80	15.91[illegible]	16.659	16.641
COMBINED NEGATIVE	RSS	1[illegible].46	.00061[illegible]	36827.	4.7[illegible]	[illegible].604	15.915	15.897

TABLE 9 (CONT'D)

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
TRAJECTORY DISPERSION ENVELOPE AT ORBIT INSERTION
COMBINED S-IB, S-IVB STAGE AND IMU THREE-SIGMA DEVIATIONS

DISPERSION GROUP		FLIGHT TIME (SEC)	SPACE FIXED AZIMUTH (DEG)
S-IB STAGE	+RSS	3.72	.085
S-IB STAGE	-RSS	3.42	.074
S-IVB STAGE	+RSS	10.34	.24[illegible]
S-IVB STAGE	-RSS	9.89	.230
IMU	+RSS	.05	.026
IMU	-RSS	.05	.02[illegible]
COMBINED POSITIVE	RSS	10.99	.25[illegible]
COMBINED NEGATIVE	RSS	10.46	.24[illegible]

TABLE 10

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
THREE-SIGMA FLIGHT ENVELOPE OF PERTINENT DESIGN PARAMETERS
FIRST STAGE FLIGHT

FLIGHT TIME (SEC)	RSS	LONGITUDINAL ACCELERATION (M/S^2)	AERO. HEATING INDICATOR $[(KG \cdot M) / (M^2 \cdot RAD)] \times (10^{-6})$	PITCH ANGLE OF ATTACK (DEG)	DYNAMIC PRESSURE (N/M^2)
0	+	0.225	0.000	0.000	0.
	-	0.246	0.000	0.000	0.
5	+	0.243	0.009	28.316	104.
	-	0.267	0.002	47.598	22.
10	+	0.258	0.012	13.939	148.
	-	0.282	0.001	25.582	96.
15	+	0.275	0.019	11.733	282.
	-	0.298	0.004	16.229	231.
20	+	0.290	0.034	12.785	490.
	-	0.312	0.014	10.234	429.
25	+	0.307	0.065	8.843	772.
	-	0.335	0.036	9.976	691.
30	+	0.324	0.123	6.227	1096.
	-	0.353	0.081	7.497	1006.
35	+	0.348	0.216	4.074	1441.
	-	0.375	0.159	5.941	1364.
40	+	0.362	0.359	2.411	1761.
	-	0.392	0.284	4.902	1743.
45	+	0.388	0.565	1.513	2003.
	-	0.415	0.466	4.392	2121.
50	+	0.360	0.842	1.069	2107.
	-	0.444	0.713	4.193	2527.
55	+	0.314	1.173	0.858	1887.
	-	0.259	1.036	3.761	2801.
60	+	0.496	1.537	0.818	1630.
	-	0.372	1.428	3.832	3130.
65	+	0.68[illegible]	1.943	0.866	1488.
	-	0.[illegible]	1.912	3.793	3870.
70	+	0.[illegible]	2.418	0.857	1390.
	-	0.749	2.546	3.866	4922.
75	+	0.757	2.844	0.627	1069.
	-	0.844	3.335	2.357	4773.

TABLE 10 (CONTINUED)

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
THREE-SIGMA FLIGHT ENVELOPE OF PERTINENT DESIGN PARAMETERS
FIRST STAGE FLIGHT

FLIGHT TIME (SEC)	RSS	LONGITUDINAL ACCELERATION (M/S^2)	AERO. HEATING INDICATOR [(KG·M) / (M^2·RAD)] X (10^{-6})	PITCH ANGLE OF ATTACK (DEG)	DYNAMIC PRESSURE (N/M^2)
80	+	0.825	3.023	0.610	2548.
	-	0.900	4.004	0.978	3791.
85	+	0.887	2.957	0.509	3617.
	-	0.961	4.312	0.698	3243.
90	+	0.934	2.787	0.630	3149.
	-	1.008	4.305	0.814	2898.
95	+	0.985	2.546	0.697	2999.
	-	1.061	4.196	0.849	2671.
100	+	1.039	2.315	0.761	2716.
	-	1.117	4.150	0.896	2444.
105	+	1.121	2.147	0.834	2475.
	-	1.194	4.232	0.953	2228.
110	+	1.236	2.109	0.858	2108.
	-	1.308	4.437	1.187	1847.
115	+	1.336	2.252	0.798	1709.
	-	1.416	4.733	1.391	1518.
120	+	1.470	2.539	0.740	1356.
	-	1.551	5.058	1.335	1211.
125	+	1.631	2.881	1.481	1050.
	-	1.691	5.403	2.037	954.
130	+	1.818	3.221	1.260	795.
	-	1.879	5.752	1.914	721.
IECO	+	0.736	3.906	1.743	379.
	-	0.825	6.208	2.148	432.
OECO	+	6.860	4.060	1.503	315.
	-	1.248	6.366	1.983	334.
SEP. SIG.	+	0.337	4.108	1.563	288.
	-	0.123	6.417	2.041	296.
SEP.	+	0.364	4.110	1.570	286.
	-	0.122	6.419	2.043	294.

TABLE 11

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
PERFORMANCE TRADE-OFFS AT S-IB/S-IVB SEPARATION

VARIATIONS	FLIGHT TIME (SEC)	ALTITUDE (M)	SPACE FIXED VELOCITY (M/S)	SPACE FIXED FLIGHT PATH ANGLE (DEG)	GROUND RANGE (M)	EARTH FIXED CROSS RANGE (M)
1) LOX LOAD MASS/(+ %)	1.30	316.	27.76	.379	1814.	-9.
1) LOX LOAD MASS/(- %)	-1.42	-352.	-29.09	-.423	-1950.	9.
2) RP-1 LOAD MASS/(+ %)	.00	-466.	-12.20	.102	-321.	1.
2) RP-1 LOAD MASS/(- %)	-.29	254.	10.39	-.166	-158.	1.
THRUST AND FLOWRATE/(+ %)	-1.40	878.	2.22	-.699	-1140.	7.
THRUST AND FLOWRATE/(- %)	1.44	-925.	-2.57	.674	1137.	-7.
ISP AND FLOWRATE/(+SEC ISP)	.48	259.	9.65	.117	713.	-4.
ISP AND FLOWRATE/(-SEC ISP)	-.48	-260.	-9.66	-.121	-706.	4.
EMR MAX RESIDUAL/(+1000 LB)	-.16	-162.	-6.38	-.022	-309.	1.
EMR MIN RESIDUAL/(-1000 LB)	.16	150.	6.68	.023	304.	-1.
NON-PROP. MASS/(+100 LB)	.00	-17.	-.44	.004	-12.	0.
NON-PROP. MASS/(-100 LB)	.00	17.	.44	-.004	12.	-0.
PITCH THRUST MIS./(+DEG)	.00	-1700.	21.38	2.021	2307.	275.
PITCH THRUST MIS./(-DEG)	.00	1651.	-22.11	-2.030	-2353.	-280.
YAW THRUST MIS./(+DEG)	.00	-16.	-8.74	-.065	334.	-3052.
YAW THRUST MIS./(-DEG)	.00	-28.	8.28	.095	-294.	3054.
ROLL THRUST MIS./(+DEG)	.00	-4.	.15	.006	3.	54.
ROLL THRUST MIS./(-DEG)	.00	2.	-.15	-.005	-2.	-54.
YCG OFFSET/(+.01 M)	.00	1.	-.24	-.002	19.	-116.
YCG OFFSET/(-.01 M)	.00	-2.	.23	.003	-19.	116.
ZCG OFFSET/(+.01 M)	.00	54.	-.83	-.06	-94.	-17.
ZCG OFFSET/(-.01 M)	.00	-55.	.81	.06	93.	17.

1) 1% = 63[illegible] Pounds

2) 1% = [illegible]9[illegible] Pounds

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TABLE 12

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
PERFORMANCE TRADE-OFFS AT ORBIT INSERTION

VARIATIONS	FLIGHT TIME (SEC)	GROUND RANGE (M)	EARTH FIXED CROSS RANGE (M)	VEHICLE WEIGHT (LB)
1) LOX LOAD MASS/(+ %)	.01	7029.	-491.	583.
1) LOX LOAD MASS/(- %)	-.08	-7529.	549.	-610.
) RP-1 LOAD MASS/(+ %)	.73	-2047.	-18.	-332.
) RP-1 LOAD MASS/(- %)	-.93	1088.	132.	288.
THRUST AND FLOWRATE/(+ %)	-1.88	-2347.	581.	219.
THRUST AND FLOWRATE/(- %)	2.04	2139.	-599.	-274.
ISP AND FLOWRATE/(+SEC ISP)	.00	2462.	-172.	215.
ISP AND FLOWRATE/(-SEC ISP)	-.02	-2533.	182.	-215.
EMR MAX RESIDUAL/(+1000 LB)	.17	-1377.	59.	-154.
EMR MIN RESIDUAL/(-1000 LB)	-.19	1393.	-56.	160.
NON-PROP. MASS/(+100 LB)	.03	-73.	-1.	-12.
NON-PROP. MASS/(-100 LB)	-.03	73.	1.	12.
PITCH THRUST MIS./(+DEG)	.24	10233.	-768.	-109.
PITCH THRUST MIS./(-DEG)	.10	-10519.	713.	-46.
YAW THRUST MIS./(+DEG)	.14	3601.	-295.	-65.
YAW THRUST MIS./(-DEG)	.29	-4043.	230.	-133.
ROLL THRUST MIS./(+DEG)	.00	-22.	1.	-0.
ROLL THRUST MIS./(-DEG)	.00	23.	-2.	-0.
YCG OFFSET/(+.01 M)	-.00	141.	-10.	1.
YCG OFFSET/(-.01 M)	.01	-145.	9.	-3.
ZCG OFFSET/(+.01 M)	.01	-369.	24.	-3.
ZCG OFFSET/(-.01 M)	-.00	363.	-25.	1.
S-IVB NPM (+100 LB)	.21	592.	-87.	5.
S-IVB NPM (-100 LB)	-.21	-593.	88.	-5.
S-IVB PITCH TH MIS/(+DEG)	.08	1463.	-120.	-37.
S-IVB PITCH TH MIS/(-DEG)	-.03	-1508.	112.	12.
S-IVB YAW TH MIS/(+DEG)	.01	539.	-42.	-3.
S-IVB YAW TH MIS/(-DEG)	.04	-589.	34.	-21.
S-IVB YCG OFFSET/(+.01 M)	-.00	57.	-0.	1.
S-IVB YCG OFFSET/(-.01 M)	.00	-59.	-0.	-2.
S-IVB ZCG OFFSET/(+.01 M)	-.00	-161.	13.	2.
S-IVB ZCG OFFSET/(-.01 M)	.01	159.	-13.	-3.
) S-IVB LOX LOAD MASS/(+ %)	4.09	11632.	-1712.	113.
) S-IVB LOX LOAD MASS/(- %)	-4.03	-11515.	1698.	-86.
) S-IVB LH2 LOAD MASS/(+ %)	.72	2346.	-342.	19.
) S-IVB LH2 LOAD MASS/(- %)	-.79	-2243.	333.	-1[illegible].

1) 1% = [illegible] Pounds

2) 1% = [illegible] Pounds

) 1% = [illegible]

) 1% = [illegible] Pounds

TABLE 13

ASTP (SA-210) L/V OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
LARGE GUIDANCE PLATFORM AZIMUTH MISALIGNMENT EFFECTS AT ORBIT INSERTION

Parameter/Azimuth Misalignment		+0.50°	+0.25°	0° (Nominal)	-0.25°	-0.50°
Flight Time (Orbit Insertion):	(sec)	0.015	0.04	594.066	0.002	0.010
Radius:	(m)	-465.	-232.	6528178.	231.	461.
Altitude:	(m)	-424.	-211.	158604.	210.	419.
Space Fixed Velocity:	(m/s)	-1.78	-0.90	7818.46	0.88	1.78
Space Fixed Flight Path Angle:	(deg)	0.019	0.009	90.001	-0.009	-0.018
Space Fixed Flight Azimuth:	(deg)	-0.534	-0.267	53.043	0.266	0.532
Earth Fixed Flight Azimuth:	(deg)	-0.551	-0.276	51.356	0.275	0.550
Geocentric Declination:	(deg)	0.113	0.057	39.264	-0.057	-0.114
Geodetic Latitude:	(deg)	0.114	0.057	39.453	-0.057	-0.115
Longitude (Positive East):	(deg)	-0.114	-0.057	-65.329	0.056	0.112
Inclination:	(deg)	0.390	0.195	51.780	-0.194	-0.389
Descending Node Argument:	(deg)	0.363	0.182	157.775	-0.183	-0.366
Inertial Range Angle:	(deg)	-0.017	-0.009	18.279	0.008	0.017
Weight:	(lb)	-7.	-2.	68340.	-1.	-5.
Space Fixed Position & Velocity Components						
Xs:	(m)	201.	100.	6202530.	-99.	-199.
Ys:	(m)	-16282.	-8144.	37898.	8150.	16304.
Zs:	(m)	-1867.	-914.	2035756.	875.	1714.
$\dot{X}$s:	(m/s)	0.57	0.31	-2422.78	-0.30	-0.60
$\dot{Y}$s:	(m/s)	-62.46	-31.24	-754.38	31.26	62.53
$\dot{Z}$s:	(m/s)	-8.33	-4.10	7395.23	3.96	7.79
Osculating Conic Parameters						
* Perigee Altitude:	(m)	-1032.	-356.	149964.	232.	285.
* Apogee Altitude:	(m)	-6786.	-3580.	164932.	3655.	7527.
Eccentricity:		-0.000440	-0.000246	0.001145	0.000261	0.000553
Semi-Major Axis:	(m)	-3909.	-1968.	6535613.	1943.	3906.
True Anomaly:	(deg)	-28.723	-10.736	358.953	6.770	11.285
Period:	(sec)	-4.72	-2.37	5258.22	2.35	4.71

* Referenced to Equatorial Radius (6378.165 km).

TABLE 14

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
S-IVB STAGE FLIGHT PERFORMANCE RESERVE

ITEM	TOLERANCE	ΔLOX REQUIRED (LBS)	ΔLH2 REQUIRED (LBS)	ΔLOX REQUIRED TRADE-OFF FACTOR (ΔLOX REQUIRED/TOL)	ΔLH2 REQUIRED TRADE-OFF FACTOR (ΔLH2 REQUIRED/TOL)
S-IB STAGE:					
NON-PROPELLANT MASS	+310LBS	30	6	.10 LB/LB	.02 LB/LB
NON-PROPELLANT MASS	-310LBS	-31	-6	-.10 LB/LB	-.02 LB/LB
THRUST MISALIGNMENT	+0.62 DEG. PITCH	56	12	90.32 LB/DEG	19.35 LB/DEG
THRUST MISALIGNMENT	-0.62 DEG. PITCH	25	5	40.32 LB/DEG	8.06 LB/DEG
THRUST MISALIGNMENT	+0.62 DEG. YAW	33	7	53.23 LB/DEG	11.29 LB/DEG
THRUST MISALIGNMENT	-0.62 DEG. YAW	68	14	109.68 LB/DEG	22.58 LB/DEG
THRUST MISALIGNMENT	+0.62 DEG. ROLL	0	0	.00 LB/DEG	.00 LB/DEG
THRUST MISALIGNMENT	-0.62 DEG. ROLL	0	0	.00 LB/DEG	.00 LB/DEG
AXIAL FORCE COEFFICIENT	MAXIMUM	378	80	NOT APPLICABLE	NOT APPLICABLE
AXIAL FORCE COEFFICIENT	MINIMUM	-362	-76	NOT APPLICABLE	NOT APPLICABLE
+YCG CENTER OF GRAVITY OFFSET	+0.05 M	-5	-1	-1.00 LB/.01 M	-.20 LB/.01 M
-YCG CENTER OF GRAVITY OFFSET	-0.05 M	12	3	2.40 LB/.01 M	.60 LB/.01 M
+ZCG CENTER OF GRAVITY OFFSET	+0.05 M	11	2	2.20 LB/.01 M	.40 LB/.01 M
-ZCG CENTER OF GRAVITY OFFSET	-0.05 M	-5	-1	-1.00 LB/.01 M	-.20 LB/.01 M
HEADWIND	(3 SIGMA/MAXIMUM)ANNUAL	215	45	NOT APPLICABLE	NOT APPLICABLE
TAILWIND	3 SIGMA ANNUAL	-459	-97	NOT APPLICABLE	NOT APPLICABLE
RIGHT CROSSWIND	3 SIGMA ANNUAL	17	4	NOT APPLICABLE	NOT APPLICABLE
LEFT CROSSWIND	(3 SIGMA/MAXIMUM)ANNUAL	17	4	NOT APPLICABLE	NOT APPLICABLE
ATMOSPHERE	HOT PROFILE	44	9	NOT APPLICABLE	NOT APPLICABLE
ATMOSPHERE	COLD PROFILE	-97	-20	NOT APPLICABLE	NOT APPLICABLE
HIGH LOX DENSITY	-3 SIGMA JULY SURFACE WINDS	36	8	NOT APPLICABLE	NOT APPLICABLE
LOW LOX DENSITY	+3 SIGMA JULY SURFACE WINDS	4	1	NOT APPLICABLE	NOT APPLICABLE
HIGH RP1 DENSITY	-3 SIGMA JULY SURFACE TEMP.	114	24	NOT APPLICABLE	NOT APPLICABLE
LOW RP1 DENSITY	+3 SIGMA JULY SURFACE TEMP.	-60	-13	NOT APPLICABLE	NOT APPLICABLE
LOX MASS	+0.45 % (2844 LBS)	-219	-46	-.08 LB/LB	-.02 LB/LB
LOX MASS	-0.60 % (3792 LBS)	302	64	.08 LB/LB	.02 LB/LB
RP1 MASS	+0.60 % (1675 LBS)	165	35	.10 LB/LB	.02 LB/LB
RP1 MASS	-0.60 % (1675 LBS)	-147	-31	-.09 LB/LB	-.02 LB/LB
THRUST AND FLOW RATE	+1.5 %	-273	-58	-182.00 LB/%	-38.67 LB/%
THRUST AND FLOW RATE	-1.5 %	339	72	226.00 LB/%	48.00 LB/%
ISP AND FLOW RATE	+1.95 SEC ISP	-351	-74	-180.00 LB/SEC	-37.95 LB/SEC
ISP AND FLOW RATE	-1.95 SEC ISP	341	72	174.87 LB/SEC	36.92 LB/SEC
ENGINE MIXTURE RATIO	MAX RESIDUAL (+2800 LBS)	352	74	.13 LB/LB	.03 LB/LB
ENGINE MIXTURE RATIO	MIN RESIDUAL (-1550 LBS)	-205	-43	-.13 LB/LB	-.03 LB/LB
H-1 ENGINE THRUST DECAY	+3 SIGMA	-15	-3	NOT APPLICABLE	NOT APPLICABLE
H-1 ENGINE THRUST DECAY	-3 SIGMA	14	3	NOT APPLICABLE	NOT APPLICABLE
S-IVB STAGE:					
NON-PROPELLANT MASS	+200 LBS	157	33	.78 LB/LB	.16 LB/LB
NON-PROPELLANT MASS	-200 LBS	-157	-33	-.78 LB/LB	-.16 LB/LB
THRUST MISALIGNMENT	+1.24 DEG. PITCH	38	8	30.65 LB/DEG	6.45 LB/DEG
THRUST MISALIGNMENT	-1.24 DEG. PITCH	-12	-3	-9.68 LB/DEG	-2.42 LB/DEG

TABLE 14 (CONT'D)

ASTP (SA-210) LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
S-IVB STAGE FLIGHT PERFORMANCE RESERVE

ITEM	TOLERANCE	ΔLOX REQUIRED (LBS)	ΔLH2 REQUIRED (LBS)	ΔLOX REQUIRED TRADE-OFF FACTOR (ΔLOX REQUIRED/TOL)	ΔLH2 REQUIRED TRADE-OFF FACTOR (ΔLH2 REQUIRED/TOL)
THRUST MISALIGNMENT	+1.24 DEG. YAW	3	1	2.42 LB/DEG	.81 LB/DEG
THRUST MISALIGNMENT	-1.24 DEG. YAW	21	4	16.94 LB/DEG	3.23 LB/DEG
+YCG CENTER OF GRAVITY OFFSET	+0.05 M	-2	0	-.40 LB/.01 M	.00 LB/.01 M
-YCG CENTER OF GRAVITY OFFSET	-0.05 M	7	1	1.40 LB/.01 M	.20 LB/.01 M
+ZCG CENTER OF GRAVITY OFFSET	+0.05 M	-9	-2	-1.80 LB/.01 M	-.40 LB/.01 M
-ZCG CENTER OF GRAVITY OFFSET	-0.05 M	14	3	2.80 LB/.01 M	.60 LB/.01 M
J-2 ENGINE THRUST DECAY	+3 SIGMA	0	0	NOT APPLICABLE	NOT APPLICABLE
J-2 ENGINE THRUST DECAY	-3 SIGMA	0	0	NOT APPLICABLE	NOT APPLICABLE
PROPULSION CASE 1	3 SIGMA	-21	-311	NOT APPLICABLE	NOT APPLICABLE
PROPULSION CASE 2	3 SIGMA	61	324	NOT APPLICABLE	NOT APPLICABLE
PROPULSION CASE 3	3 SIGMA	-547	4	NOT APPLICABLE	NOT APPLICABLE
PROPULSION CASE 4	3 SIGMA	529	-1	NOT APPLICABLE	NOT APPLICABLE
PROPULSION CASE 5	3 SIGMA	-426	419	NOT APPLICABLE	NOT APPLICABLE
PROPULSION CASE 6	3 SIGMA	426	-408	NOT APPLICABLE	NOT APPLICABLE
PROPULSION CASE 7	3 SIGMA	68	-151	NOT APPLICABLE	NOT APPLICABLE
PROPULSION CASE 8	3 SIGMA	-45	155	NOT APPLICABLE	NOT APPLICABLE
LOX MASS	+0.645 % (1259 LBS)	-261	211	-.21 LB/LB	.17 LB/LB
LOX MASS	-0.645 % (1259 LBS)	275	-208	.22 LB/LB	-.17 LB/LB
LH2 MASS	+0.902 % (349 LBS)	280	-290	.80 LB/LB	-.83 LB/LB
LH2 MASS	-0.902 % (349 LBS)	-270	292	-.77 LB/LB	.84 LB/LB
REQUIRED FLIGHT PERFORMANCE RESERVE (3 SIGMA) (RSS OF POSITIVE PROPELLANT REQUIRED DEVIATIONS)		1172	683		