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FINAL PREDICTED TRAJECTORY AND DISPERSION STUDY FOR SATURN I VEHICLE SA-7 (U)

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TECHNICAL MEMORANDUM X-53120

FINAL PREDICTED TRAJECTORY AND DISPERSION STUDY FOR SATURN I VEHICLE SA-7

By

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ABSTRACT

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This report presents the final predicted standard trajectory and dispersion analysis for Saturn I vehicle SA-7 to be flown over the Atlantic Missile Range. The nominal impact area of the S-I booster and the recoverable camera capsules is presented, along with a discussion of the trajectory shaping and a description of the vehicle configuration.

The nominal trajectory will insert the S-IV stage and payload into a near-circular orbit with a perigee and apogee of 182 km and 229 km altitude, respectively. The nominal lifetime of the orbit is 3.2 days.

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Author

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NASA-GEORGE C. MARSHALL SPACE FLIGHT CENTER

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FLIGHT EVALUATION AND OPERATIONS STUDIES DIVISION
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TECHNICAL MEMORANDUM X-53120

FINAL PREDICTED TRAJECTORY AND DISPERSION STUDY FOR SATURN I VEHICLE SA-7

SUMMARY

The Saturn I vehicle SA-7 trajectory is shaped for orbital insertion at 185.5 km (100 n.m.) with a velocity 13 m/sec in excess of the local circular velocity. This approximates the earth parking orbit to be used in lunar missions.

The S-I stage pitch program is shaped to minimize angle of attack through the high dynamic pressure region under a non-wind condition. Although the expected launch date is mid-September, launch dates through the end of October will be permissible under 3σ wind conditions without pitch program reshaping. The S-I stage pitch program is implemented by means of a time function polynomial. The S-IV stage is closed-loop guided by means of the minimax adaptive guidance mode in the pitch plane and delta minimum mode in crossrange.

The vehicle will be propelled to an altitude of 71 km by the S-I stage booster, where a single plane separation between the S-I and S-IV stages will occur. After approximately 2 seconds of ullage rocket operation, the S-IV mainstage will ignite and burn continuously until 619 seconds after lift-off, resulting in the cutoff conditions of 7806 m/sec velocity, 89.954 degrees path angle (down from local vertical) and 185.53 kilometers altitude.

Orbital insertion time is defined to be 10 seconds after guidance computer cutoff signal. This is deemed sufficient to allow complete S-IV mainstage thrust decay. The combined S-IV stage, instrument unit, and payload will have initial perigee and apogee altitudes of 182 and 229 km, respectively, when referenced to a spherical earth of radius 6378 km. Nominal orbital lifetime is 3.2 days.

Twenty-five seconds after separation the camera capsules will be ejected from the S-I stage. The nominal impact area of the capsules is 26.2619 degrees North geodetic latitude and 72.6130 degrees West longitude. This is 825.5 km downrange.

A two-sigma guidance scheme envelope is generated by applying two-sigma perturbations independently to each stage of the nominal profile and root-sum-squaring the resulting dispersions.

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SECTION I. INTRODUCTION

The primary objective of the Block II SA-7 vehicle test flight is to prove the integrity of the propulsion, structural, guidance, and flight control system operating as a two stage Saturn I launch vehicle system.

The SA-7 vehicle consists of the S-I and S-IV live stages, an instrument unit, and an Apollo boilerplate payload (Figure 1).

The S-I stage has eight H-1 engines, which have a nominal sea level thrust value of 836,000 newtons (188,000 lbf) each and burn high-grade kerosene and liquid oxygen as propellant.

The S-IV second stage is a liquid-hydrogen liquid-oxygen propulsion system, generating thrust through six concentrically located RL-10A3 engines, which will propel the S-IV stage with a total thrust of 400,000 newtons (90,000 lbf) under vacuum conditions. The interstage acts as a supporting structure and an aerodynamic fairing for the mating of the S-I and S-IV stages. A single plane separation mode will be employed.

The instrument unit is located just forward of S-IV stage and aft of the Apollo payload. The I.U. provides an environmentally conditioned compartment to house electronic equipment such as guidance and control, telemetry, electrical power sources, etc.

The Apollo boilerplate payload consists of a spacecraft adapter, a service module, a command module, and a launch escape system. The boilerplate will be used to determine the launch and exit environmental parameters and to test the launch escape system's structural and jettison characteristics. The launch escape and pitch motors will be utilized for launch escape system jettison.

The current launch schedule calls for a mid-September launch date from the Atlantic Missile Range facilities, Complex 37, Pad B. Launch azimuth is 90 degrees East-of-North.

At pitch tilt initiation the vehicle will simultaneously begin a 15 degree roll maneuver so as to become aligned with the 105 degree East-of-North flight plane azimuth. The booster stage pitch program is shaped to minimize the angle of attack during the period of highest dynamic pressure. There is no bias for wind. The second stage guidance will be implemented by a minimax adaptive guidance polynomial in the pitch plane. Crossrange guidance is predicated upon minimization of the first and second integral of the inertial crossrange acceleration.

Information concerning orbital lifetime, debris, etc., is contributed by the Operations Studies Branch, R-AERO-FO.

SECTION II. DESCRIPTION

The flight mechanical mission for this vehicle is a near-circular 185 km (100 n.m.) orbit. A slightly super-circular cutoff velocity of 7806 m/sec is selected in order to insure against hardware or scheme malfunctions resulting in sub-circular insertion conditions.

The nominal profile and orbital parameters reflect the final predicted vehicle characteristics, including S-IV stage thrust decay (References 1 and 2). Nominal operation of all vehicle and flight supporting components is assumed, with the exception that the S-IV stage Propellant Utilization System is assumed to operate non-optimally by a 2σ magnitude (Reference 3). Two-sigma Propellant Utilization System operation will permit 151 kg (333 lbm) of otherwise usable LOX or LH_2 to remain onboard if propellant depletion of this stage occurs.

The Pad 37B launch facility is constructed for vehicle launch on a 90 degree East-of-North azimuth. The research and development nature of this flight requires the tracking facilities available along the 105 degree East-of-North flight azimuth. The ST-124 stabilized platform is aligned along this 105-degree azimuth. The SA-7 vehicle will rise vertically for 10 seconds in order to clear the launch facilities and then simultaneously begin its pitch program and roll maneuver. The roll rate will be nominally 1 degree per second (Reference 4) and will bring Fins I and III into the flight plane. Previously, the ST-90 stabilized platform system was incapable of this commanded combination pitch and roll motion, and vehicles SA-5 and SA-6 were forced to complete their roll maneuver prior to pitch tilting.

The S-I boost stage pitch program is shaped to provide maximum flight performance reserve propellant at S-IV stage cutoff while minimizing aerodynamic moments during the peak dynamic pressure region and at separation. This program is implemented on board the vehicle as a time function polynomial. Based on 3σ wind limitations (Reference 5), no reshaping will be necessary for launch dates through October. A tilt arrest angle of 67 degrees is programmed at 136 seconds after lift-off to insure ample time for damping various transient motions in order to avoid premature cutoff and separation sequencing due to propellant sloshing. The separation sequence of events is commanded from a timer, which is initiated by propellant level sensors (Reference 6). The S-IV stage minimax adaptive guidance polynomial (Table 1) is derived from a trajectory volume generated about a nominal profile having 7806 m/s velocity, 90 deg path angle, and 185.2 km altitude end conditions, and which is optimized by the variational calculus method. This polynomial generates the attitude command from the state variables and is identical to the one employed on vehicle SA-6. The entire nominal pitch program is graphically presented in Figure 2 and presented to the instant of

guidance initiation in detailed tabular form in Table 2. The orientation reference of the vehicle pitch program is a space-fixed vertical, defined at the instant of launch. Pitch tilting takes place about an axis normal to the space-fixed plane, containing the space-fixed vertical reference line and the downrange direction at launch. The crossrange guidance employs the delta minimum principle, guiding on first and second integrals of the inertial accelerometers. The S-IV stage guidance loop for both pitch and crossrange is closed 18 seconds after S-I stage outboard cutoff.

A combination of 8 onboard movie cameras will view propellant level behavior in the S-I stage, as well as several aspects of stage separation. These cameras are mounted on the S-I stage and will be ejected 25 seconds after stage separation.

The Launch Escape System (LES) and ullage rocket casings will be jettisoned from the S-IV stage 12 seconds after stage separation. The LES will fire the launch escape and pitch motors.

The major events sequence is presented in Table 3.

The dispersions resulting from guidance scheme errors were obtained by applying the following 2σ perturbation magnitudes to the nominal profile:

A. S-I Stage

1.	Non-Propellant Mass	+ 167 kg (369 lbm)
2.	Propellant Loading Mass	- 938 kg (-2068 lbm)
3.	Thrust and Flow Rate (I_{sp} = Constant)	- 1 %
4.	Flow Rate	+ 1 %
5.	Thrust Misalignment	.37 deg
6.	Mixture Ratio Shift	- .528 %
7.	Longitudinal Drag Coefficient	+ 10 %
8.	Headwind	
9.	Tailwind	
10.	Left Cross Wind	
11.	Right Cross Wind	

B. S-IV Stage

1.	Non-Propellant Mass	+ 37 kg (81 lbm)
2.	Propellant Loading Mass	- 605 kg (-1333 lbm)
3.	Thrust and Flow Rate (I_{sp} = Constant)	- 0.5 %
4.	Flow Rate	+ 0.5 %
5.	Thrust Misalignment	.41 deg
6.	Mixture Ratio	+ 8.5 %

The thrust misalignments are applied normal to the flight plane for both stages. Application of a thrust vector misalignment correction program (Reference 7) in the flight plane during the S-IV stage minimizes deviations in this plane due to c.g. offsets and thrust misalignment. This method is not applied in the crossrange direction on SA-7.

All perturbations, with the exception of the wind cases, will result in approximately symmetric deviations about the nominal when applied in a "plus and minus" fashion. The perturbations are therefore only applied in a manner which will result in a decrement in the residual usable propellants. The root-sum-square values are computed using the symmetric-type perturbation results, both positively and negatively, in conjunction with results of the non-symmetric perturbations.

$$\text{Positive RSS} = +\sqrt{\Sigma(+\Delta P)^2} \qquad \text{Negative RSS} = +\sqrt{\Sigma(-\Delta P)^2}$$

$$\text{RSS} = \frac{\text{Positive RSS} + \text{Negative RSS}}{2},$$

$$\text{where } \Delta P = (\text{variation value}) - (\text{standard value})$$

Results obtained from the application of the various perturbations are used to compute performance partial derivatives. These "partials" are an attempt to indicate the performance behavior of this vehicle and caution as to their area of applicability must be exercised.

Averaged thrust, flow rate, and specific impulse information for each stage is presented in the Appendix for flight evaluation purposes.

SECTION III. RESULTS

A. POWERED FLIGHT

A detailed presentation of the predicted nominal trajectory parameters is presented in Tables 4A through 8B. Important points through the flight history are denoted. The trajectory data are presented in five sections: (1) S-I stage boost flight; (2) S-IV stage ullage rocket operation after separation but prior to mainstage ignition; (3) S-IV mainstage operation; (4) S-I stage post-separation retro-rocket operation; and (5) S-I stage ballistic flight to impact. A graphic presentation of the nominal profile is presented in Figure 3.

The nominal trajectory presentation and guidance scheme dispersions do not reflect effects of hardware deviations characteristic of this vehicle. However, the orbital insertion and nominal lifetime characteristics (see B, Orbital Flight) reflect known accelerometer non-orthogonalities (Reference 8) and guidance computer signal delay to the propellant valve solenoids (.022 seconds). The superposition of these two deviations results in the following increments: (1) +0.1 m/sec velocity; (2) +.017 degrees velocity vector elevation above the horizon; and (3) +240 m radial position. The velocity accumulation during S-IV thrust decay is 1.57 m/sec. The platform leveling has a predicted 3σ uncertainty of ±18 arc seconds, resulting in approximately ±1 meter/second velocity uncertainty. The actual leveling position cannot be ascertained until immediately prior to lift-off, and its effect is therefore not included in these results. Incorporation of the available deviations results in a predicted nominal cutoff velocity of 7806.10 m/sec and insertion velocity of 7807.67 m/sec with a ±1 m/sec 3σ uncertainty.

The dispersions presented in Tables 9A through 11B are scheme errors associated with the open-loop guidance system employed in the S-I stage. The dispersions presented in Tables 12A through 16 are scheme errors associated with the minimax adaptive polynomial employed on the S-IV stage. Partial derivatives of several state parameters, with respect to the perturbing parameters applicable to S-I outboard cutoff and S-IV cutoff/insertion, are presented in Tables 17 and 18. These partials are not indicative of hardware uncertainty effects but reflect only the guidance scheme errors.

The 2σ impact dispersion for the separated S-I booster is graphically presented in Figure 4. The nominal booster impact position is 825.1 km downrange at 26.2631 North geodetic latitude and 72.6164 West longitude. Superimposed is the nominal impact position of the camera pods. The camera pod nominal impact and dispersion are essentially identical to that of the booster.

B. ORBITAL FLIGHT

The nominal lifetime of SA-7 is 3.2 ± 0.2 days (49 ± 3 earth revolutions). The quoted lifetime uncertainty (± 3 earth revolutions) considers only the RSS dispersion due to vehicle performance deviations and the uncertainty in the density profile prediction, and does not incorporate random guidance hardware uncertainties. The nominal lifetime includes the effects of known guidance hardware deviations outlined in the Powered Flight discussion. Figure 5 is a ground projecting plot showing the locus of the SA-7 nominal orbital re-entry. The nominal re-entry orbit (earth revolution 49) is denoted by the heavy dark line. Also shown are the three revolutions prior to and after the nominal re-entry orbit.

The lifetime was defined by integrating the orbit to impact using the nominal insertion conditions and the following ballistic parameters for a tumbling vehicle.

C_DA	174.0 m^2
Post Venting Orbital Mass	16430 kg
Ballistic Coefficient (C_DA/M)	0.01058 m^2/kg

The atmosphere assumed in the drag model was the 1959 ARDC multiplied by a factor of 0.64. This adjustment factor was determined empirically from the observed decay histories of the SA-5, SA-6, and GT-1 flights, and is the ratio of the observed drag to that predicted using the 1959 ARDC atmosphere. This factor adjusts for variations of actual from assumed values of drag coefficient, vehicle attitude, and atmospheric density. The orbital venting configuration has been modified on SA-7, and there is a possible change in attitude characteristics from that experienced on SA-5 and SA-6.

The nominal initial decay rate of the orbit is approximately 14 km/day in apogee altitude and 8 km/day in perigee altitude.

B. ORBITAL FLIGHT (Continued)

I. ORBITAL INSERTION CHARACTERISTICS

1. Insertion Conditions (S-IV C.O. + 10 sec)

Time (F.T. sec)	628.968
Space-fixed velocity (m/s)	7807.67
Elevation of space-fixed velocity (deg)	0.066
Azimuth of space-fixed velocity (deg from North)	113.950
Altitude from earth center (km)	6561.05
Geocentric latitude (deg)	21.509
Longitude (deg East)	299.348
Excess circular velocity (m/s)	13.2
Ground range (km)	2145.381

2. Orbital Elements*

Apogee altitudes** (km)	228.92
Perigee altitude** (km)	181.65
Anomalistic period (min)	88.60
Semi-major axis (km)	6583.45
Eccentricity	0.0036
Inclination (deg)	31.761
Longitude of ascending node (deg East)	158.885
Argument of perigee (deg)	117.171
True anomaly at insertion (deg)	18.677
Regression rate of node (deg/day)	-8.0
Rate of change of argument of perigee (deg/day)	12.0

II. LIFETIME CHARACTERISTICS

Nominal Lifetime (days)	3.2
Lifetime deviation due to 1σ vehicle performance deviations and density uncertainty (days)	±0.2
Ballistic parameters for tumbling vehicle:	
C_DA	174.0 m^2
Post venting orbital mass	16430 kg
Ballistic coefficient (C_DA/M)	0.01058 m^2/kg

*Inertial orientation of earth at insertion is at 0.0 hr U.T. and sidereal time is zero for simplicity.

**Apogee and perigee altitudes are referenced to spherical earth of radius 6378.165 km.

APPENDIX

PREDICTED VEHICLE CHARACTERISTICS FOR
FLIGHT EVALUATION COMPARISON

S-I STAGE

F_{vs1} = Average vehicle longitudinal thrust, reduced to sea level conditions*

= 6,730,639 N (1,513,108 lb)

$\dot{M}_v$ = Average vehicle flow rate

= 2,694 kg/sec (5,940. lbm/sec)

ISP_{vs1} = Average vehicle longitudinal specific impulse, reduced to sea level conditions.

= 254.7 sec

S-IV STAGE

F_{vv1} = Average vehicle longitudinal vacuum thrust**

= 399,500 N (89,811 lbs)

$\dot{M}_v$ = 95.0 kg/sec*** (209.4 lb/sec)

ISP_{vv1} = Average vehicle longitudinal vacuum specific impulse

= 428.9 sec

*Predicted vacuum thrust values are computed and then averaged using 2 second increments from lift-off to 140 second flight time. The average is then reduced to approximately sea level by applying atmospheric pressure = 101,525 n/m^2 over each of the engine exit areas.

**Predicted thrust values are averaged in increments of 10 seconds, beginning 10 seconds after S-IV ignition and terminating 480 seconds after ignition.

***Flow rate is determined from mass loss between LES and ullage cases jettison to S-IV cutoff divided by the corresponding period of time. Flow rates do not reflect LES and ullage case masses.

TABLE 1

SECOND STAGE STEERING EQUATION

$$
\begin{aligned}
X_p = {} & A_1 + A_2 x + A_3 y + A_4 \dot{x} + A_5 \dot{y} + A_6 \frac{F}{m} + A_7 T + A_8 xy + A_9 \dot{x}y + A_{10}\dot{x}^2 \\
& + A_{11} x\dot{y} + A_{12} y\dot{y} + A_{13} y \frac{F}{m} + A_{14}\left(\frac{F}{m}\right)^2 + A_{15}\dot{x}T + A_{16}T^2 + A_{17}x^3 + A_{18}xy^2 \\
& + A_{19} y\dot{x}^2 + A_{20} y^2 \frac{F}{m} + A_{21} y\dot{x} \frac{F}{m} + A_{22} x\dot{y} \frac{F}{m} + A_{23}\dot{x}\dot{y} \frac{F}{m} + A_{24}\dot{y}\left(\frac{F}{m}\right)^2 + A_{25}x^2 T \\
& + A_{26} y^2 T + A_{27} y\dot{x}T + A_{28}\dot{x}\dot{y}T + A_{29}\dot{x} \frac{F}{m} T + A_{30}\left(\frac{F}{m}\right)^2 T + A_{31} xT^2 + A_{32}\dot{x}T^2 \\
& + A_{33}\dot{y}T^2 .
\end{aligned}
$$

VARIABLE	COEFFICIENT*	VARIABLE	COEFFICIENT*
A_1	$-.38819016 \times 10^{+2}$	A_{18}	$.23911714 \times 10^{-16}$
A_2	$.36608441 \times 10^{-5}$	A_{19}	$-.28013517 \times 10^{-11}$
A_3	$-.50399775 \times 10^{-3}$	A_{20}	$.58251509 \times 10^{-11}$
A_4	$-.65673288 \times 10^{-1}$	A_{21}	$-.66542957 \times 10^{-9}$
A_5	$.78848666 \times 10^{-1}$	A_{22}	$-.26290587 \times 10^{-9}$
A_6	$.78960371 \times 10^{+1}$	A_{23}	$-.10951379 \times 10^{-6}$
A_7	$.96218603 \times 10^{0}$	A_{24}	$.22721801 \times 10^{-4}$
A_8	$.49583253 \times 10^{-9}$	A_{25}	$.90608805 \times 10^{-13}$
A_9	$.19192036 \times 10^{-6}$	A_{26}	$-.13793533 \times 10^{-12}$
A_{10}	$.10608304 \times 10^{-4}$	A_{27}	$-.14992977 \times 10^{-9}$
A_{11}	$-.71545723 \times 10^{-7}$	A_{28}	$.79442788 \times 10^{-8}$
A_{12}	$.15238895 \times 10^{-6}$	A_{29}	$-.15858595 \times 10^{-5}$
A_{13}	$.36148663 \times 10^{-4}$	A_{30}	$.28478054 \times 10^{-3}$
A_{14}	$-.55735608 \times 10^{-1}$	A_{31}	$.33341993 \times 10^{-9}$
A_{15}	$-.18185596 \times 10^{-3}$	A_{32}	$.19609307 \times 10^{-6}$
A_{16}	$-.13521339 \times 10^{-2}$	A_{33}	$.25250709 \times 10^{-6}$
A_{17}	$-.10493679 \times 10^{-17}$		

The S-IV stage thrust termination signal will occur when space-fixed velocity reaches 7806.00 m/sec.

*These coefficients are scaled.

TABLE 2

PITCH TILT PROGRAM FOR SATURN I VEHICLE SA-7

Flight Time (sec)	(deg)	Flight Time (sec)	(deg)	Flight Time (sec)	(deg)	Flight Time (sec)	(deg)
0	0	38	12.38	76	38.04	114	57.51
1	0	39	13.15	77	38.70	115	57.94
2	0	40	13.92	78	39.35	116	58.37
3	0	41	14.71	79	40.00	117	58.80
4	0	42	15.51	80	40.63	118	59.23
5	0	43	16.12	81	41.26	119	59.67
6	0	44	16.72	82	41.87	120	60.10
7	0	45	17.30	83	42.49	121	60.53
8	0	46	17.71	84	43.08	122	60.96
9	0	47	18.11	85	43.68	123	61.39
10	0	48	18.64	86	44.26	124	61.82
11	.16	49	19.17	87	44.84	125	62.25
12	.32	50	19.87	88	45.40	126	62.69
13	.49	51	20.57	89	45.96	127	63.12
14	.66	52	21.28	90	46.50	128	63.55
15	.84	53	21.98	91	47.04	129	63.98
16	1.05	54	22.69	92	47.57	130	64.41
17	1.27	55	23.39	93	48.09	131	64.84
18	1.51	56	24.10	94	48.60	132	65.27
19	1.80	57	24.81	95	49.10	133	65.71
20	2.10	58	25.51	96	49.59	134	66.14
21	2.47	59	26.22	97	50.08	135	66.57
22	2.85	60	26.93	98	50.55	136	67.00
23	3.28	61	27.64	99	51.02	*165	67.00
24	3.72	62	28.34	100	51.47		
25	4.20	63	29.05	101	51.90		
26	4.68	64	29.76	102	52.33		
27	5.21	65	30.47	103	52.76		
28	5.75	66	31.18	104	53.20		
29	6.33	67	31.88	105	53.63		
30	6.91	68	32.58	106	54.06		
31	7.53	69	33.28	107	54.49		
32	8.16	70	33.97	108	54.92		
33	8.82	71	34.67	109	55.35		
34	9.49	72	35.35	110	55.78		
35	10.19	73	36.04	111	56.22		
36	10.90	74	36.71	112	56.65		
37	11.64	75	37.38	113	57.08		

*Time of Adaptive Guidance Initiation

TABLE 3

NOMINAL SEQUENCE OF EVENTS

Time of Event (From Lift-Off)	Remarks
0.0	Lift-Off
10.0	Initiate Roll and Pitch Tilt
25.0	Terminate Roll
134.9	Signal from Sequencer to Enable Level Sensors
136.0	Tilt Arrest
138.9	S-I Stage Level Sensor Signal
140.9	Inboard Cutoff (S-I Stage)
146.9	Outboard Cutoff (S-I Stage)
147.6	Ullage Rocket Ignition (S-IV Stage)
147.7	Separation, Immediately Followed by Retro Rocket Ignition (S-I Stage)
149.4	S-IV Mainstage Ignition
159.7	Jettison Ullage Rocket Casing and LES
165.0	Initiate Active Guidance
172.7	Ejection of Camera Capsules from Booster
585.0	Signal from Sequencer to Arm LOX Cutoff Capability
619.0	S-IV Stage Guidance Cutoff Signal
625.0	End of Powered Flight

TABLE 4A
S-I STAGE BOOST TRAJECTORY

TIME (SEC)	GRØUND DISTANCE (KM)	ALTITUDE (KM)	SPACE FIXED VELØCITY (M/SEC)	SPACE FIXED PATH ANGLE (DEG)	ACCELERATIØN V DØT EARTH-FIXED (M/SEC SQ)	MASS (KG)	DYNAMIC PRESSURE (N/M SQ)	THRUST (N)	MACH	DRAG (N)
0.0	-0.00	0.03	408.9	90.00	3.07	510706	0	6625422	0.00	44130
5.0	-0.00	0.07	409.3	87.62	3.66	497332	170	6704812	0.05	21457
10.0	-0.00	0.21	410.5	84.91	4.10	483958	770	6758689	0.11	43557
15.0	-0.00	0.44	413.3	81.94	4.54	470476	1911	6805288	0.17	69761
20.0	0.01	0.79	419.0	78.75	4.99	456994	3683	6846246	0.24	99466
25.0	0.02	1.26	428.6	75.44	5.48	443485	6130	6893171	0.32	134193
30.0	0.07	1.87	443.5	72.15	6.01	429976	9255	6947553	0.40	177658
35.0	0.16	2.62	464.8	69.06	6.60	416464	12996	7008610	0.50	236652
40.0	0.33	3.53	493.0	66.33	7.24	402952	17220	7073232	0.61	308576
45.0	0.61	4.61	528.1	64.08	7.87	389451	21712	7139525	0.73	422059
50.0	1.01	5.84	567.1	62.17	8.37	375951	26109	7208801	0.86	606098
55.0	1.56	7.25	610.1	60.82	8.31	362407	29782	7276425	1.01	1010980
60.0	2.28	8.81	656.5	60.03	9.08	348862	32343	7339601	1.17	1126229
65.0	3.20	10.53	709.3	59.55	10.31	335299	34161	7399117	1.37	1105679
(1) 70.0	4.36	12.41	770.0	59.31	11.89	321735	34903	7454672	1.59	1007439
75.0	5.79	14.46	839.6	59.28	13.71	308202	33881	7503374	1.85	866420
80.0	7.55	16.70	918.8	59.43	15.70	294669	30745	7539882	2.13	706955
85.0	9.68	19.14	1008.4	59.72	17.85	281211	25871	7568437	2.39	536008
90.0	12.23	21.79	1108.8	60.14	20.04	267754	21194	7589907	2.67	396610
95.0	15.27	24.66	1219.9	60.67	22.27	254293	16957	7603418	2.99	285048
100.0	18.84	27.76	1342.1	61.26	24.58	240832	13254	7611201	3.35	196001
105.0	23.01	31.11	1475.7	61.88	26.97	227376	9987	7612992	3.72	132477
110.0	27.82	34.71	1621.1	62.54	29.50	213920	7294	7609968	4.10	89099
115.0	33.35	38.58	1779.3	63.22	32.20	200485	5184	7601260	4.51	59299
120.0	39.65	42.72	1951.5	63.93	35.19	187049	3612	7590726	4.93	39437
125.0	46.80	47.15	2139.4	64.68	38.58	173652	2492	7582709	5.42	20362
130.0	54.90	51.86	2345.3	65.47	42.43	160255	1737	7573348	6.06	9212
135.0	64.03	56.88	2571.3	66.28	46.72	146876	1182	7540011	6.89	3874
140.0	74.30	62.20	2820.2	67.04	51.69	133496	757	7480833	7.90	858
(2)140.87	76.21	63.16	2866.0	67.15	52.59	131168	695	7463515	8.10	565
141.9	78.45	64.28	2900.3	67.29	26.83	129050	618	4011578	8.26	329
(3)146.87	90.03	69.92	3032.4	67.93	26.59	122489	320	3758412	9.02	234
146.9	90.18	69.99	3034.1	67.93	26.63	122326	317	3758412	9.03	234
(4)147.7	91.94	70.83	3038.9	68.03	-1.78	121705	283	278950	9.10	217

(1) High q
(2) Inboard Cutoff
(3) Outboard Cutoff
(4) Separation

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TABLE 4B
S-I STAGE BOOST TRAJECTORY

	TIME (SEC)	XXXE (KM)	YYYE (KM)	ZZZE (KM)	DXXE (M/SEC)	DYYE (M/SEC)	DZZE (M/SEC)	VELØCITY (M/SEC)	PATH ANGLE (DEG)	LØNGITUDE (PØSITIVE WEST) (DEG)	GEØD. LAT. (PØSITIVE NØRTH) (DEG)	GEØC. LAT. (PØSITIVE NØRTH) (DEG)
					EARTH FIXED PARAMETERS							
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	80.5650	28.5319	28.3707
	5.0	-0.0	0.1	-0.0	-0.0	17.0	-0.1	17.0	0.48	80.5650	28.5319	28.3707
	10.0	-0.0	0.2	-0.0	-0.1	36.4	-0.2	36.4	0.49	80.5650	28.5319	28.3707
	15.0	-0.0	0.4	-0.0	0.2	58.0	-0.2	58.0	0.42	80.5650	28.5319	28.3707
	20.0	0.0	0.8	-0.0	1.9	81.8	-0.3	81.8	1.35	80.5649	28.5319	28.3707
	25.0	0.0	1.3	-0.0	5.9	107.8	-0.3	107.9	3.13	80.5647	28.5319	28.3707
	30.0	0.1	1.9	-0.0	13.5	135.9	-0.3	136.6	5.64	80.5643	28.5318	28.3706
	35.0	0.2	2.6	-0.0	25.7	166.1	-0.3	168.1	8.77	80.5633	28.5316	28.3704
	40.0	0.3	3.5	-0.0	43.7	197.9	-0.2	202.7	12.40	80.5616	28.5312	28.3701
	45.0	0.6	4.6	-0.0	67.7	230.8	-0.2	240.5	16.31	80.5589	28.5306	28.3695
	50.0	1.0	5.8	-0.0	94.9	264.7	-0.1	281.2	19.67	80.5549	28.5297	28.3686
	55.0	1.6	7.3	-0.0	126.7	297.4	0.1	323.2	23.02	80.5494	28.5285	28.3673
	60.0	2.3	8.8	-0.0	163.4	327.8	0.2	366.2	26.44	80.5423	28.5268	28.3657
	65.0	3.2	10.5	-0.0	206.9	359.2	0.4	414.6	29.87	80.5333	28.5247	28.3635
(1)	70.0	4.4	12.4	-0.0	258.3	392.6	0.7	470.0	33.26	80.5218	28.5220	28.3609
	75.0	5.8	14.5	-0.0	318.7	428.4	1.0	533.9	36.55	80.5077	28.5187	28.3576
	80.0	7.6	16.7	0.0	388.8	466.6	1.3	607.4	39.69	80.4904	28.5146	28.3535
	85.0	9.7	19.1	0.0	469.3	507.4	1.7	691.2	42.64	80.4694	28.5096	28.3485
	90.0	12.3	21.8	0.0	560.9	550.5	2.2	785.9	45.38	80.4442	28.5036	28.3425
	95.0	15.3	24.6	0.0	663.6	595.6	2.7	891.7	47.91	80.4142	28.4964	28.3354
	100.0	18.9	27.7	0.0	777.7	642.5	3.2	1008.8	50.22	80.3790	28.4880	28.3270
	105.0	23.1	31.1	0.1	903.3	691.5	3.8	1137.6	52.32	80.3380	28.4781	28.3171
	110.0	28.0	34.7	0.1	1041.2	742.3	4.5	1278.7	54.22	80.2905	28.4667	28.3057
	115.0	33.6	38.5	0.1	1192.4	794.6	5.2	1432.9	55.98	80.2361	28.4535	28.2926
	120.0	39.9	42.6	0.1	1358.2	848.0	6.0	1601.2	57.62	80.1741	28.4385	28.2777
	125.0	47.2	47.0	0.2	1540.5	902.5	7.0	1785.4	59.17	80.1036	28.4214	28.2606
	130.0	55.4	51.6	0.2	1741.8	957.6	8.1	1987.7	60.67	80.0240	28.4020	28.2413
	135.0	64.6	56.6	0.3	1964.3	1013.4	9.3	2210.3	62.09	79.9342	28.3800	28.2194
	140.0	75.1	61.8	0.3	2209.4	1072.7	10.8	2456.1	63.39	79.8333	28.3552	28.1947
(2)	140.87	77.0	62.7	0.3	2254.2	1084.2	11.0	2501.4	63.59	79.8145	28.3506	28.1901
	141.9	79.3	63.8	0.3	2288.9	1090.0	11.3	2535.2	63.79	79.7924	28.3452	28.1847
(3)	146.87	91.1	69.3	0.4	2425.7	1103.6	12.8	2665.0	64.68	79.6787	28.3171	28.1567
	146.9	91.2	69.3	0.4	2427.4	1103.8	12.8	2666.6	64.69	79.6773	28.3167	28.1563
(4)	147.7	93.0	70.2	0.4	2434.0	1100.0	13.0	2671.1	64.81	79.6600	28.3124	28.1520

(1) High q
(2) Inboard Cutoff
(3) Outboard Cutoff
(4) Separation

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TABLE 5A
S-IV STAGE ULLAGE TRAJECTORY

TIME (SEC)	GRØUND DISTANCE (KM)	ALTITUDE (KM)	SPACE FIXED VELØCITY (M/SEC)	SPACE FIXED PATH ANGLE (DEG)	ACCELERATIØN V DØT EARTH-FIXED (M/SEC SQ)	MASS (KG)	DYNAMIC PRESSURE (N/M SQ)	THRUST (N)	MACH	DRAG (N)
147.7	91.94	70.83	3038.9	68.03	-3.13	65491	283	62517	9.10	972
147.75	92.13	70.92	3038.7	68.04	-3.13	65487	279	62517	9.10	960
149.4	96.00	72.74	3034.4	68.28	-3.08	65415	214	62517	9.20	734

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TABLE 5B
S-IV STAGE ULLAGE TRAJECTORY

TIME (SEC)	XXXE (KM)	YYYE (KM)	ZZZE (KM)	DXXE (M/SEC)	DYYE (M/SEC)	DZZE (M/SEC)	VELØCITY (M/SEC)	PATH ANGLE (DEG)	LØNGITUDE (PØSITIVE WEST) (DEG)	GEØD. LAT. (PØSITIVE NØRTH) (DEG)	GEØC. LAT. (PØSITIVE NØRTH) (DEG)
	EARTH FIXED PARAMETERS										
147.7	93.0	70.2	0.4	2434.0	1100.0	13.0	2671.1	64.81	79.6600	28.3124	28.1520
147.75	93.2	70.2	0.4	2434.1	1099.2	13.0	2670.8	64.83	79.6581	28.3119	28.1516
149.4	97.1	72.0	0.4	2435.0	1084.8	13.3	2665.8	65.08	79.6201	28.3025	28.1422

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TABLE 6A
S-IV MAINSTAGE TRAJECTORY

TIME (SEC)	GRØUND DISTANCE (KM)	ALTITUDE (KM)	SPACE FIXED VELØCITY (M/SEC)	SPACE FIXED PATH ANGLE (DEG)	ACCELERATIØN V DØT EARTH-FIXED (M/SEC SQ)	MASS (KG)	DYNAMIC PRESSURE (N/M SQ)	THRUST (N)	MACH	DRAG (N)
(1) 149.4	96.00	72.74	3034.4	68.28	-3.09	65415	214	63256	9.20	1852
150.0	97.51	73.45	3032.8	68.36	-2.68	65365	192	75279	9.23	1650
155.0	109.50	78.95	3041.7	69.05	2.31	64966	83	402972	9.61	714
160.0	121.60	84.31	3056.1	69.72	2.88	61397	34	408233	9.96	294
165.0	133.83	89.53	3073.0	70.37	3.03	60900	13	408058	10.01	121
170.0	146.18	94.61	3090.5	71.01	3.21	60405	5	407869	9.70	46
175.0	158.66	99.57	3108.7	71.64	3.38	59922	2	407589	9.41	19
180.0	171.27	104.39	3127.8	72.27	3.55	59439	1	407294	8.98	8
185.0	184.01	109.07	3147.6	72.88	3.71	58956	0	406893	8.62	4
190.0	196.88	113.63	3168.1	73.49	3.87	58474	0	406497	8.06	2
195.0	209.89	118.06	3189.4	74.08	4.02	57992	0	406134	7.57	1
200.0	223.04	122.36	3211.3	74.67	4.18	57511	0	405774	6.98	1
205.0	236.32	126.53	3234.0	75.24	4.33	57030	0	405437	6.40	0
210.0	249.74	130.58	3257.3	75.80	4.48	56549	0	405208	5.98	0
215.0	263.30	134.50	3281.4	76.35	4.65	56067	0	405729	5.65	0
220.0	277.01	138.30	3306.2	76.89	4.82	55585	0	406223	5.39	0
225.0	290.86	141.98	3331.8	77.42	4.98	55102	0	406522	5.18	0
230.0	304.86	145.53	3358.2	77.94	5.14	54618	0	406757	5.01	0
235.0	319.01	148.97	3385.2	78.45	5.28	54134	0	406554	4.86	0
240.0	333.32	152.29	3412.9	78.94	5.43	53651	0	406317	4.77	0
245.0	347.77	155.49	3441.3	79.43	5.57	53168	0	405857	4.70	0
250.0	362.39	158.58	3470.3	79.91	5.70	52685	0	405345	4.64	0
255.0	377.16	161.55	3499.9	80.37	5.83	52205	0	404465	4.61	0
260.0	392.09	164.41	3530.1	80.82	5.95	51725	0	403613	4.60	0
265.0	407.18	167.16	3560.8	81.26	6.07	51247	0	402954	4.59	0
270.0	422.43	169.80	3592.2	81.68	6.20	50769	0	402318	4.58	0
275.0	437.84	172.33	3624.1	82.10	6.33	50292	0	401846	4.59	0
280.0	453.43	174.76	3656.6	82.50	6.46	49816	0	401384	4.60	0
285.0	469.18	177.08	3689.7	82.89	6.58	49340	0	400991	4.62	0
290.0	485.10	179.30	3723.4	83.27	6.71	48865	0	400638	4.64	0
295.0	501.19	181.41	3757.7	83.64	6.85	48390	0	400558	4.66	0
300.0	517.46	183.43	3792.7	84.01	6.99	47915	0	400472	4.68	0
305.0	533.90	185.35	3828.4	84.36	7.12	47440	0	400345	4.70	0
310.0	550.53	187.17	3864.6	84.70	7.26	46965	0	400208	4.73	0
315.0	567.34	188.89	3901.6	85.03	7.39	46491	0	399999	4.76	0
320.0	584.33	190.51	3939.1	85.36	7.52	46016	0	399797	4.79	0
325.0	601.51	192.05	3977.3	85.67	7.65	45542	0	399638	4.83	0
330.0	618.88	193.49	4016.1	85.97	7.79	45068	0	399478	4.87	0
335.0	636.44	194.84	4055.6	86.27	7.92	44595	0	399318	4.91	0
340.0	654.20	196.10	4095.7	86.55	8.06	44121	0	399156	4.95	0

(1) S-IV Mainstage Ignition

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TABLE 6A (Continued)
S-IV MAINSTAGE TRAJECTORY

TIME (SEC)	GRØUND DISTANCE (KM)	ALTITUDE (KM)	SPACE FIXED VELØCITY (M/SEC)	SPACE FIXED PATH ANGLE (DEG)	ACCELERATIØN V DØT EARTH-FIXED (M/SEC SQ)	MASS (KG)	DYNAMIC PRESSURE (N/M SQ)	THRUST (N)	MACH	DRAG (N)
345.0	672.16	197.27	4136.5	86.83	8.19	43648	0	398983	5.00	0
350.0	690.31	198.35	4177.9	87.09	8.33	43175	0	398814	5.04	0
355.0	708.68	199.35	4220.0	87.35	8.46	42702	0	398680	5.09	0
360.0	727.24	200.27	4262.8	87.60	8.60	42230	0	398547	5.14	0
365.0	746.02	201.11	4306.2	87.84	8.74	41757	0	398418	5.19	0
370.0	765.01	201.86	4350.4	88.07	8.88	41285	0	398294	5.24	0
375.0	784.22	202.54	4395.2	88.29	9.02	40813	0	398199	5.29	0
380.0	803.65	203.13	4440.7	88.51	9.17	40341	0	398109	5.35	0
385.0	823.29	203.66	4486.9	88.71	9.31	39869	0	398055	5.40	0
390.0	843.17	204.11	4533.9	88.91	9.46	39397	0	398004	5.46	0
395.0	863.27	204.48	4581.5	89.10	9.61	38925	0	397972	5.52	0
400.0	883.61	204.79	4630.0	89.28	9.76	38454	0	397941	5.58	0
405.0	904.18	205.03	4679.2	89.46	9.92	37982	0	397926	5.64	0
410.0	925.00	205.19	4729.1	89.62	10.08	37510	0	397921	5.71	0
415.0	946.06	205.30	4779.9	89.78	10.24	37038	0	397988	5.77	0
420.0	967.36	205.34	4831.4	89.93	10.40	36566	0	398044	5.84	0
425.0	988.92	205.32	4883.8	90.07	10.57	36094	0	398028	5.91	0
430.0	1010.73	205.24	4937.0	90.21	10.73	35622	0	397996	5.98	0
435.0	1032.81	205.10	4991.0	90.33	10.90	35150	0	397853	6.06	0
440.0	1055.14	204.91	5045.9	90.45	11.06	34678	0	397708	6.13	0
445.0	1077.75	204.66	5101.5	90.56	11.23	34207	0	397549	6.21	0
450.0	1100.63	204.37	5158.1	90.67	11.41	33735	0	397412	6.28	0
455.0	1123.78	204.02	5215.5	90.76	11.59	33264	0	397420	6.36	0
460.0	1147.22	203.63	5273.8	90.85	11.78	32793	0	397429	6.45	0
465.0	1170.94	203.20	5333.1	90.93	11.97	32321	0	397439	6.53	0
470.0	1194.96	202.72	5393.4	91.00	12.17	31850	0	397459	6.61	0
475.0	1219.27	202.21	5454.6	91.07	12.37	31378	0	397553	6.70	0
480.0	1243.88	201.66	5516.9	91.13	12.58	30907	0	397641	6.79	0
485.0	1268.79	201.07	5580.2	91.18	12.79	30435	0	397688	6.88	0
490.0	1294.02	200.46	5644.6	91.23	13.01	29963	0	397738	6.98	0
495.0	1319.57	199.81	5710.1	91.27	13.23	29492	0	397816	7.07	0
500.0	1345.44	199.14	5776.8	91.30	13.46	29020	0	397886	7.17	0
505.0	1371.63	198.45	5844.6	91.32	13.70	28548	0	397907	7.27	0
510.0	1398.16	197.75	5913.6	91.34	13.94	28076	0	397912	7.37	0
515.0	1425.04	197.02	5983.8	91.35	14.18	27604	0	397809	7.47	0
520.0	1452.25	196.28	6055.2	91.35	14.43	27133	0	397712	7.58	0
525.0	1479.83	195.54	6127.9	91.35	14.69	26661	0	397668	7.69	0
530.0	1507.76	194.79	6201.9	91.34	14.96	26190	0	397636	7.80	0
535.0	1536.05	194.04	6277.3	91.32	15.24	25718	0	397694	7.91	0
540.0	1564.72	193.29	6354.1	91.29	15.53	25246	0	397748	8.03	0

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TABLE 6A (Continued)
S-IV MAINSTAGE TRAJECTORY

TIME (SEC)	GRØUND DISTANCE (KM)	ALTITUDE (KM)	SPACE FIXED VELØCITY (M/SEC)	SPACE FIXED PATH ANGLE (DEG)	ACCELERATIØN V DØT EARTH-FIXED (M/SEC SQ)	MASS (KG)	DYNAMIC PRESSURE (N/M SQ)	THRUST (N)	MACH	DRAG (N)
545.0	1593.77	192.55	6432.4	91.26	15.83	24775	0	397776	8.14	0
550.0	1623.21	191.82	6512.3	91.22	16.14	24303	0	397797	8.26	0
555.0	1653.05	191.10	6593.7	91.17	16.46	23831	0	397772	8.38	0
560.0	1683.28	190.41	6676.8	91.12	16.80	23360	0	397761	8.51	0
565.0	1713.93	189.74	6761.6	91.06	17.15	22888	0	397841	8.63	0
570.0	1745.00	189.10	6848.1	90.99	17.51	22416	0	397927	8.77	0
575.0	1776.50	188.49	6936.6	90.92	17.90	21944	0	398056	8.90	0
580.0	1808.43	187.93	7027.0	90.84	18.30	21472	0	398159	9.04	0
585.0	1840.81	187.41	7119.4	90.75	18.70	20999	0	398078	9.18	0
590.0	1873.65	186.94	7213.9	90.65	19.12	20527	0	397982	9.32	0
595.0	1906.96	186.53	7310.5	90.55	19.56	20055	0	397771	9.46	0
600.0	1940.75	186.18	7409.4	90.44	20.01	19584	0	397519	9.60	0
605.0	1975.02	185.89	7510.6	90.32	20.47	19113	0	396972	9.75	0
610.0	2009.79	185.69	7614.1	90.20	20.96	18643	0	396412	9.90	0
615.0	2045.08	185.57	7720.1	90.06	21.46	18174	0	395754	10.05	0
(2) 619.0	2073.45	185.54	7806.0	89.95	21.88	17803	0	395231	10.16	0
620.1	2080.64	185.54	7807.4	89.95	0.02	17776	0	399	10.17	0
(3) 625.1	2116.61	185.53	7807.5	89.95	0	17774	0	0	10.17	0
(4) 629.0	2145.38	185.53	7807.6	89.95	0	17772	0	0	10.17	0

(2) Thrust Termination Signal
(3) End of Thrust Decay
(4) Insertion

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TABLE 6B
S-IV MAINSTAGE TRAJECTORY

TIME (SEC)	XXXE (KM)	YYYE (KM)	ZZZE (KM)	EARTH FIXED PARAMETERS DXXE (M/SEC)	DYYE (M/SEC)	DZZE (M/SEC)	VELØCITY (M/SEC)	PATH ANGLE (DEG)	LØNGITUDE (PØSITIVE WEST) (DEG)	GEØD. LAT. (PØSITIVE NØRTH) (DEG)	GEØC. LAT. (PØSITIVE NØRTH) (DEG)
(1) 149.4	97.1	72.0	0.4	2435.0	1084.8	13.3	2665.8	65.08	79.6201	28.3025	28.1422
150.0	98.7	72.7	0.4	2435.4	1079.2	13.4	2663.9	65.18	79.6053	28.2988	28.1385
155.0	110.9	78.0	0.5	2458.0	1043.8	14.1	2670.5	65.96	79.4877	28.2695	28.1093
160.0	123.3	83.1	0.6	2485.1	1010.4	15.0	2682.7	66.74	79.3690	28.2397	28.0796
165.0	135.8	88.1	0.6	2513.9	978.0	15.9	2697.5	67.50	79.2492	28.2095	28.0495
170.0	148.4	92.9	0.7	2542.9	945.7	19.5	2713.1	68.24	79.1283	28.1788	28.0189
175.0	161.2	97.6	0.8	2572.1	913.4	22.8	2729.6	68.98	79.0062	28.1475	27.9878
180.0	174.1	102.0	1.0	2601.6	881.1	25.9	2746.9	69.71	78.8830	28.1157	27.9561
185.0	187.2	106.4	1.1	2631.4	848.8	28.7	2765.0	70.43	78.7586	28.0833	27.9238
190.0	200.4	110.5	1.2	2661.3	816.5	31.4	2784.0	71.13	78.6330	28.0503	27.8909
195.0	213.8	114.5	1.4	2691.5	784.4	33.8	2803.7	71.82	78.5063	28.0168	27.8575
200.0	227.4	118.4	1.6	2721.9	752.3	36.1	2824.2	72.50	78.3783	27.9827	27.8236
205.0	241.0	122.1	1.8	2752.5	720.4	38.2	2845.5	73.17	78.2490	27.9481	27.7890
210.0	254.9	125.6	2.0	2783.3	688.5	40.1	2867.5	73.82	78.1185	27.9129	27.7540
215.0	268.9	128.9	2.2	2814.4	656.7	42.0	2890.3	74.46	77.9868	27.8771	27.7184
220.0	283.0	132.2	2.4	2845.8	624.8	43.7	2914.0	75.08	77.8537	27.8408	27.6822
225.0	297.3	135.2	2.6	2877.6	593.0	45.3	2938.4	75.70	77.7194	27.8039	27.6454
230.0	311.8	138.1	2.8	2909.7	561.1	46.9	2963.7	76.30	77.5837	27.7664	27.6081
235.0	326.4	140.8	3.1	2942.2	529.2	48.4	2989.8	76.89	77.4467	27.7283	27.5702
240.0	341.2	143.4	3.3	2974.8	497.4	49.8	3016.5	77.47	77.3083	27.6897	27.5317
245.0	356.2	145.8	3.6	3007.8	465.6	51.2	3044.0	78.03	77.1686	27.6504	27.4926
250.0	371.3	148.0	3.8	3041.0	433.8	52.6	3072.2	78.58	77.0275	27.6106	27.4529
255.0	386.6	150.1	4.1	3074.3	402.1	53.9	3101.0	79.11	76.8849	27.5701	27.4126
260.0	402.0	152.0	4.4	3107.9	370.5	55.2	3130.4	79.63	76.7410	27.5291	27.3716
265.0	417.7	153.8	4.7	3141.7	339.0	56.6	3160.5	80.14	76.5956	27.4874	27.3301
270.0	433.5	155.4	4.9	3175.8	307.6	57.9	3191.2	80.63	76.4487	27.4450	27.2879
275.0	449.4	156.9	5.2	3210.1	276.2	59.2	3222.5	81.10	76.3005	27.4020	27.2451
280.0	465.6	158.2	5.5	3244.6	244.8	60.6	3254.4	81.57	76.1507	27.3584	27.2016
285.0	481.9	159.3	5.8	3279.5	213.4	61.9	3287.0	82.01	75.9995	27.3141	27.1575
290.0	498.4	160.3	6.1	3314.7	182.0	63.3	3320.3	82.45	75.8467	27.2691	27.1127
295.0	515.0	161.2	6.5	3350.2	150.6	64.7	3354.2	82.88	75.6925	27.2234	27.0672
300.0	531.9	161.8	6.8	3386.0	119.2	66.1	3388.7	83.29	75.5367	27.1771	27.0210
305.0	548.9	162.4	7.1	3422.2	87.6	67.5	3424.0	83.69	75.3793	27.1300	26.9741
310.0	566.1	162.7	7.5	3458.8	56.0	69.0	3459.9	84.08	75.2204	27.0822	26.9265
315.0	583.5	162.9	7.8	3495.8	24.3	70.5	3496.6	84.46	75.0599	27.0336	26.8781
320.0	601.0	163.0	8.2	3533.1	-7.4	72.0	3533.8	84.82	74.8978	26.9843	26.8290
325.0	618.8	162.8	8.5	3570.8	-39.2	73.6	3571.7	85.18	74.7340	26.9342	26.7791
330.0	636.8	162.6	8.9	3608.9	-71.1	75.1	3610.3	85.52	74.5686	26.8834	26.7285
335.0	654.9	162.1	9.3	3647.4	-103.0	76.7	3649.6	85.85	74.4015	26.8317	26.6771
340.0	673.2	161.5	9.7	3686.2	-135.1	78.4	3689.6	86.17	74.2327	26.7793	26.6248

(1) S-IV Mainstage Ignition

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TABLE 6B (Continued)
S-IV MAINSTAGE TRAJECTORY

TIME (SEC)	XXXE (KM)	YYYE (KM)	ZZZE (KM)	DXXE (M/SEC)	DYYE (M/SEC)	DZZE (M/SEC)	VELØCITY (M/SEC)	PATH ANGLE (DEG)	LØNGITUDE (PØSITIVE WEST) (DEG)	GEØD. LAT. (PØSITIVE NØRTH) (DEG)	GEØC. LAT. (PØSITIVE NØRTH) (DEG)
				EARTH FIXED PARAMETERS							
345.0	691.8	160.8	10.1	3725.6	-167.2	80.1	3730.2	86.48	74.0622	26.7260	26.5717
350.0	710.5	159.9	10.5	3765.3	-199.5	81.8	3771.5	86.78	73.8900	26.6718	26.5178
355.0	729.4	158.8	10.9	3805.4	-231.8	83.5	3813.4	87.07	73.7161	26.6169	26.4630
360.0	748.5	157.5	11.3	3846.1	-264.3	85.3	3856.1	87.35	73.5403	26.5610	26.4074
365.0	767.9	156.1	11.7	3887.1	-296.9	87.1	3899.4	87.62	73.3628	26.5043	26.3509
370.0	787.4	154.6	12.2	3928.6	-329.6	88.9	3943.5	87.87	73.1834	26.4466	26.2935
375.0	807.2	152.8	12.6	3970.7	-362.5	90.7	3988.2	88.12	73.0022	26.3880	26.2351
380.0	827.1	151.0	13.1	4013.2	-395.5	92.6	4033.7	88.36	72.8191	26.3285	26.1759
385.0	847.3	148.9	13.6	4056.2	-428.7	94.5	4079.9	88.59	72.6341	26.2680	26.1156
390.0	867.7	146.7	14.0	4099.7	-462.1	96.5	4126.8	88.80	72.4473	26.2066	26.0544
395.0	888.3	144.3	14.5	4143.7	-495.6	98.4	4174.4	89.01	72.2584	26.1441	25.9923
400.0	909.1	141.7	15.0	4188.4	-529.4	100.4	4222.9	89.21	72.0676	26.0807	25.9291
405.0	930.2	139.0	15.5	4233.5	-563.3	102.4	4272.1	89.40	71.8749	26.0162	25.8648
410.0	951.5	136.1	16.0	4279.3	-597.5	104.5	4322.0	89.59	71.6800	25.9506	25.7995
415.0	973.0	133.0	16.6	4325.6	-631.8	106.5	4372.8	89.76	71.4832	25.8840	25.7332
420.0	994.7	129.8	17.1	4372.6	-666.4	108.6	4424.4	89.92	71.2843	25.8163	25.6658
425.0	1016.7	126.3	17.7	4420.2	-701.3	110.8	4476.8	90.08	71.0832	25.7475	25.5972
430.0	1038.9	122.7	18.2	4468.4	-736.4	112.9	4530.1	90.22	70.8801	25.6775	25.5275
435.0	1061.4	119.0	18.8	4517.2	-771.7	115.1	4584.1	90.36	70.6747	25.6064	25.4567
440.0	1084.1	115.0	19.4	4566.7	-807.3	117.3	4639.0	90.49	70.4672	25.5340	25.3847
445.0	1107.0	110.9	20.0	4616.9	-843.1	119.6	4694.7	90.61	70.2574	25.4605	25.3115
450.0	1130.3	106.6	20.6	4667.7	-879.1	121.8	4751.3	90.72	70.0454	25.3858	25.2370
455.0	1153.7	102.1	21.2	4719.3	-915.4	124.1	4808.8	90.83	69.8312	25.3098	25.1614
460.0	1177.5	97.4	21.8	4771.5	-951.9	126.5	4867.2	90.92	69.6146	25.2325	25.0844
465.0	1201.4	92.6	22.4	4824.6	-988.8	128.8	4926.6	91.01	69.3956	25.1539	25.0061
470.0	1225.7	87.6	23.1	4878.4	-1026.1	131.2	4986.9	91.09	69.1743	25.0739	24.9266
475.0	1250.2	82.3	23.8	4933.1	-1063.6	133.6	5048.2	91.16	68.9505	24.9927	24.8456
480.0	1275.0	76.9	24.4	4988.6	-1101.6	136.1	5110.6	91.22	68.7243	24.9100	24.7633
485.0	1300.1	71.3	25.1	5044.9	-1139.9	138.6	5174.0	91.28	68.4956	24.8259	24.6796
490.0	1325.5	65.5	25.8	5102.2	-1178.6	141.1	5238.4	91.32	68.2644	24.7404	24.5944
495.0	1351.1	59.5	26.5	5160.4	-1217.7	143.7	5304.0	91.36	68.0306	24.6533	24.5078
500.0	1377.1	53.3	27.3	5219.5	-1257.2	146.3	5370.7	91.40	67.7943	24.5648	24.4196
505.0	1403.3	47.0	28.0	5279.6	-1297.1	148.9	5438.6	91.42	67.5552	24.4748	24.3300
510.0	1429.9	40.4	28.7	5340.7	-1337.4	151.6	5507.7	91.44	67.3135	24.3831	24.2388
515.0	1456.7	33.6	29.5	5402.8	-1378.2	154.3	5578.0	91.45	67.0690	24.2899	24.1459
520.0	1483.9	26.6	30.3	5466.0	-1419.4	157.0	5649.5	91.45	66.8218	24.1950	24.0515
525.0	1511.4	19.4	31.1	5530.3	-1461.0	159.8	5722.2	91.45	66.5718	24.0984	23.9553
530.0	1539.2	12.0	31.9	5595.7	-1503.2	162.6	5796.3	91.43	66.3188	24.0002	23.8575
535.0	1567.4	4.4	32.7	5662.3	-1545.8	165.5	5871.8	91.41	66.0630	23.9002	23.7579
540.0	1595.8	-3.5	33.5	5730.1	-1589.0	168.4	5948.7	91.38	65.8043	23.7983	23.6566

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TABLE 6B (Continued)
S-IV MAINSTAGE TRAJECTORY

	TIME (SEC)	XXXE (KM)	YYYE (KM)	ZZZE (KM)	EARTH FIXED PARAMETERS DXXE (M/SEC)	DYYE (M/SEC)	DZZE (M/SEC)	VELOCITY (M/SEC)	PATH ANGLE (DEG)	LONGITUDE (POSITIVE WEST) (DEG)	GEOD. LAT. (POSITIVE NORTH) (DEG)	GEOC. LAT. (POSITIVE NORTH) (DEG)
	545.0	1624.7	-11.5	34.4	5799.2	-1632.7	171.4	6027.1	91.35	65.5425	23.6947	23.5534
	550.0	1653.8	-19.8	35.3	5869.6	-1677.0	174.4	6107.0	91.30	65.2777	23.5892	23.4484
	555.0	1683.4	-28.3	36.1	5941.4	-1722.0	177.4	6188.5	91.25	65.0098	23.4818	23.3415
	560.0	1713.3	-37.0	37.0	6014.7	-1767.5	180.5	6271.6	91.19	64.7387	23.3724	23.2326
	565.0	1743.5	-46.0	37.9	6089.4	-1813.8	183.7	6356.5	91.13	64.4643	23.2610	23.1217
	570.0	1774.2	-55.2	38.9	6165.7	-1860.7	186.8	6443.1	91.05	64.1868	23.1476	23.0088
	575.0	1805.2	-64.6	39.8	6243.7	-1908.4	190.1	6531.6	90.97	63.9058	23.0321	22.8938
	580.0	1836.6	-74.3	40.8	6323.3	-1956.9	193.4	6622.0	90.89	63.6215	22.9144	22.7767
	585.0	1868.4	-84.2	41.7	6404.8	-2006.2	196.8	6714.5	90.79	63.3337	22.7945	22.6574
	590.0	1900.6	-94.3	42.7	6488.1	-2056.3	200.2	6809.1	90.69	63.0424	22.6724	22.5358
	595.0	1933.3	-104.7	43.7	6573.2	-2107.3	203.7	6905.7	90.58	62.7474	22.5479	22.4120
	600.0	1966.4	-115.4	44.8	6660.4	-2159.2	207.3	7004.7	90.46	62.4488	22.4211	22.2857
	605.0	1999.9	-126.3	45.8	6749.5	-2212.0	210.9	7105.9	90.34	62.1465	22.2918	22.1571
	610.0	2033.9	-137.5	46.9	6840.8	-2265.8	214.6	7209.4	90.21	61.8403	22.1601	22.0260
	615.0	2068.3	-149.0	48.0	6934.1	-2320.6	218.3	7315.4	90.07	61.5303	22.0258	21.8924
(2)	619.0	2096.0	-158.3	48.8	7009.9	-2365.0	221.4	7401.4	89.95	61.2814	21.9174	21.7844
	620.1	2103.0	-160.6	49.1	7008.6	-2373.1	221.7	7402.8	89.95	61.2104	21.8864	21.7536
(3)	625.1	2138.0	-172.6	50.2	6995.2	-2412.6	223.4	7403.0	89.95	60.8956	21.7482	21.6161
(4)	629.0	2166.0	-182.3	51.1	6984.3	-2444.1	224.7	7403.0	89.95	60.6521	21.6406	21.5090

(2) Thrust Termination Signal
(3) End of Thrust Decay
(4) Insertion

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TABLE 7A
S-I STAGE POST-SEPARATION RETRO TRAJECTORY

	TIME (SEC)	GRØUND DISTANCE (KM)	ALTITUDE (KM)	SPACE FIXED VELØCITY (M/SEC)	SPACE FIXED PATH ANGLE (DEG)	ACCELERATIØN V DØT EARTH-FIXED (M/SEC SQ)	MASS (KG)	DYNAMIC PRESSURE (N/M SQ)	THRUST (N)	MACH	DRAG (N)
(1)	147.7	91.94	70.83	3038.9	68.03	-9.64	56313	283	-269352	9.10	44437
	147.75	92.13	70.92	3038.1	68.05	-9.90	56282	279	-284352	9.10	43842
	149.3	95.76	72.63	3020.1	68.27	-14.93	55683	215	-573525	9.14	33780
	149.9	97.30	73.35	3010.8	68.37	-11.43	55527	192	-382350	9.15	30142
(2)	150.1	97.77	73.57	3009.3	68.40	-4.53	55502	185	0	9.16	29126

(1) Retro Ignition
(2) Retro E.T.D.

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TABLE 7B
S-I STAGE POST-SEPARATION RETRO TRAJECTORY

	TIME (SEC)	XXXE (KM)	YYYE (KM)	ZZZE (KM)	DXXE (M/SEC)	DYYE (M/SEC)	DZZE (M/SEC)	VELØCITY (M/SEC)	PATH ANGLE (DEG)	LØNGITUDE (PØSITIVE WEST) (DEG)	GEØD. LAT. (PØSITIVE NØRTH) (DEG)	GEØC. LAT. (PØSITIVE NØRTH) (DEG)
	EARTH FIXEC PARAMETERS											
(1)	147.7	93.0	70.2	C.4	2434.0	1100.0	13.0	2671.1	64.81	79.6600	28.3124	28.1520
	147.75	93.2	70.2	C.4	2433.6	1099.0	13.0	2670.3	64.83	79.6581	28.3119	28.1516
	149.3	96.9	71.9	C.4	2421.5	1080.0	13.3	2651.5	65.06	79.6225	28.3031	28.1428
	149.9	98.5	72.6	C.4	2414.9	1071.3	13.5	2641.9	65.16	79.6074	28.2993	28.1390
(2)	150.1	99.0	72.8	C.4	2414.1	1069.2	13.5	2640.3	65.19	79.6027	28.2982	28.1379

(1) Retro Ignition
(2) Retro E.T.D.

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TABLE 8A
S-I STAGE POST-SEPARATION FREE FLIGHT TRAJECTORY

	TIME (SEC)	GROUND DISTANCE (KM)	ALTITUDE (KM)	SPACE FIXED VELOCITY (M/SEC)	SPACE FIXED PATH ANGLE (DEG)	ACCELERATION V DOT EARTH-FIXED (M/SEC SQ)	MASS (KG)	DYNAMIC PRESSURE (N/M SQ)	THRUST (N)	MACH	DRAG (N)
	150.1	97.77	73.57	3009.3	68.40	-4.53	55502	185	0	9.16	29175
	153.0	104.59	76.72	2998.1	68.82	-4.26	55502	114	0	9.31	17944
(1)	173.0	151.70	96.67	2931.9	71.80	-3.41	55298	3	0	8.99	480
	193.0	198.50	113.28	2877.5	74.90	-2.84	55298	0	0	7.25	29
	213.0	245.05	126.58	2833.4	78.11	-2.25	55298	0	0	5.48	5
	233.0	291.40	136.57	2799.9	81.39	-1.63	55298	0	0	4.55	2
	253.0	337.62	143.27	2777.2	84.74	-1.00	55298	0	0	4.12	1
	273.0	383.76	146.68	2765.6	88.13	-0.35	55298	0	0	3.94	1
	284.0	409.14	147.15	2764.0	90.00	0.01	55298	0	0	3.91	1
	293.0	429.87	146.80	2765.1	91.53	0.30	55298	0	0	3.93	1
	313.0	476.01	143.64	2775.7	94.92	0.95	55298	0	0	4.10	1
	333.0	522.23	137.20	2797.4	98.27	1.58	55298	0	0	4.51	2
	353.0	568.59	127.46	2830.0	101.57	2.20	55298	0	0	5.38	4
	373.0	615.14	114.42	2873.1	104.78	2.79	55298	0	0	7.10	24
	390.8	656.84	100.00	2920.3	107.55	3.29	55298	2	0	8.73	262
	393.0	661.94	98.06	2926.6	107.89	3.35	55298	2	0	8.88	371
	413.0	709.04	78.38	2988.7	110.88	3.65	55298	87	0	9.39	13753
	433.0	756.31	55.44	3025.8	113.72	-1.25	55298	2042	0	8.25	312727
	453.0	800.15	31.21	2447.7	115.77	-83.59	55298	33359	0	6.84	4894903
	473.0	820.07	18.26	853.3	111.80	-39.34	55298	15790	0	1.74	2517092
	493.0	823.77	13.98	530.4	109.66	-2.27	55298	5001	0	0.68	611370
	513.0	824.78	10.52	471.4	110.29	-1.41	55298	5449	0	0.55	610068
	533.0	825.06	7.49	446.5	108.35	-1.06	55298	5503	0	0.44	597058
	553.0	825.13	4.87	436.5	106.28	-0.80	55298	5473	0	0.37	583548
	573.0	825.14	2.57	431.7	104.52	-0.62	55298	5419	0	0.32	573220
	593.0	825.15	0.51	428.8	103.14	-0.46	55298	5370	0	0.28	564606
(2)	598.3	825.15	0.00	428.2	102.84	-0.42	55298	5357	0	0.27	562446

(1) Jettison Camera Capsules
(2) Theoretical Ballistic Impact

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TABLE 8B
S-I STAGE POST-SEPARATION FREE FLIGHT TRAJECTORY

	TIME (SEC)	XXXE (KM)	YYYE (KM)	ZZZE (KM)	EARTH FIXED PARAMETERS DXXE (M/SEC)	DYYE (M/SEC)	DZZE (M/SEC)	VELØCITY (M/SEC)	PATH ANGLE (DEG)	LØNGITUDE (PØSITIVE WEST) (DEG)	GEØD. LAT. (PØSITIVE NØRTH) (DEG)	GEØC. LAT. (PØSITIVE NØRTH) (DEG)
	150.1	99.0	72.8	0.4	2414.1	1069.2	13.5	2640.3	65.19	79.6027	28.2982	28.1379
	153.0	105.9	75.9	0.5	2412.2	1042.0	14.1	2627.7	65.65	79.5358	28.2815	28.1212
(1)	173.0	154.1	94.8	0.8	2404.4	856.8	18.1	2552.5	68.98	79.0743	28.1649	28.0051
	193.0	202.1	110.1	1.2	2397.2	673.3	21.9	2490.1	72.49	78.6170	28.0468	27.8874
	213.0	249.9	121.8	1.7	2389.2	490.7	25.6	2439.2	76.15	78.1635	27.9271	27.7682
	233.0	297.6	129.8	2.2	2380.2	308.8	29.1	2400.4	79.95	77.7131	27.8057	27.6472
	253.0	345.1	134.1	2.8	2370.4	127.4	32.5	2374.1	83.84	77.2652	27.6826	27.5246
	273.0	392.4	134.9	3.5	2359.7	-53.6	35.7	2360.6	87.81	76.8193	27.5575	27.4000
	284.0	418.4	133.7	3.9	2353.4	-153.2	37.4	2358.7	90.00	76.5746	27.4879	27.3306
	293.0	439.5	132.0	4.3	2348.1	-234.5	38.8	2360.1	91.79	76.3749	27.4305	27.2735
	313.0	486.4	125.5	5.1	2335.6	-415.4	41.7	2372.6	95.76	75.9315	27.3014	27.1449
	333.0	532.9	115.4	5.9	2322.1	-596.5	44.5	2397.9	99.66	75.4886	27.1701	27.0141
	353.0	579.2	101.6	6.8	2307.7	-778.0	47.1	2435.8	103.47	75.0456	27.0365	26.8810
	373.0	625.2	84.2	7.8	2292.3	-960.0	49.5	2485.8	107.14	74.6020	26.9004	26.7454
	390.8	666.0	65.7	8.7	2277.8	-1123.0	51.5	2540.1	110.29	74.2057	26.7768	26.6224
	393.0	670.9	63.2	8.8	2275.9	-1142.9	51.7	2547.3	110.66	74.1573	26.7616	26.6072
	413.0	716.3	38.5	9.9	2257.3	-1326.0	53.7	2618.5	114.00	73.7110	26.6201	26.4663
	433.0	761.1	10.3	11.0	2208.5	-1491.3	54.8	2665.4	117.18	73.2643	26.4762	26.3230
	453.0	801.9	-19.1	12.0	1656.9	-1283.2	42.7	2096.1	120.51	72.8513	26.3412	26.1885
	473.0	820.1	-34.5	12.5	342.0	-364.1	9.2	499.6	129.36	72.6640	26.2792	26.1268
	493.0	823.2	-39.2	12.6	61.8	-188.1	1.8	198.0	154.35	72.6293	26.2677	26.1153
	513.0	823.8	-42.8	12.6	4.3	-165.5	0.2	165.5	171.06	72.6198	26.2645	26.1121
	533.0	823.6	-45.8	12.6	-11.9	-140.2	-0.2	140.7	177.40	72.6172	26.2635	26.1112
	553.0	823.4	-48.5	12.6	-14.4	-121.5	-0.3	122.4	179.29	72.6166	26.2633	26.1109
	573.0	823.1	-50.7	12.6	-13.6	-107.4	-0.3	108.2	179.74	72.6164	26.2632	26.1108
	593.0	822.8	-52.8	12.6	-12.4	-96.7	-0.3	97.5	179.82	72.6164	26.2631	26.1108
(2)	598.3	822.8	-53.3	12.6	-12.1	-94.4	-0.2	95.1	179.82	72.6164	26.2631	26.1108

(1) Jettison Camera Capsules
(2) Theoretical Ballistic Impact

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TABLE 9A

S-I STAGE STATE PARAMETERS AT ØUTBØARD CUT-ØFF

RESULTING FRØM TWØ-SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		TIME FRØM LIFTØFF (SEC)	PATH ANGLE EARTH FIXED (DEG)	VELØCITY EARTH FIXED (M/SEC)	ALTITUDE (M)	RANGE (M)	INTEGRATED INERTIAL ACCELERATIØNS X1-DØT (M/SEC)	ETA-DØT (M/SEC)	ZETA-DØT (M/SEC)
NØMINAL		146.870	64.684	2664.98	69916.4	90029.4	2450.29	2504.67	-8.39
NØN-PRØPELLANT MASS	+167 kg	-.000	.015	-2.71	-90.5	-66.3	-2.21	-1.69	.01
PRØPELLANT LØADING MASS	-938 kg	-.350	-.148	-4.57	84.4	-510.3	-7.15	1.25	.03
THRUST AND FLØW RATE	-1 %	1.423	.728	-4.61	-1184.7	1485.3	9.89	-19.67	-.03
FLØW RATE	+1 %	-1.395	-.407	-33.08	-783.5	-2553.4	-38.75	-8.59	.13
THRUST MISALIGNMENT	.37 deg	-.000	.004	-.14	-12.3	-17.1	-.42	-.24	-35.63
MIXTURE RATIØ	-.528 %	-.200	-.036	-11.33	-241.9	-503.7	-11.18	-4.76	.04
AXIAL DRAG CØEFFICIENT	+10 %	.000	.177	-13.99	-970.3	-562.6	-9.63	-12.81	.03
HEADWIND		.000	-.011	-4.98	-92.4	-589.8	-4.93	-1.31	-3.11
TAILWIND		-.000	.442	27.49	-690.9	3345.3	34.30	-9.12	8.85
LEFT CRØSS WIND		.000	.083	-.33	-218.8	-.7	1.28	-3.62	12.36
RIGHT CRØSS WIND		-.000	.171	6.68	-321.0	859.2	9.33	-4.89	-19.98
PØSITIVE RSS		2.033	.991	47.63	1741.5	4635.8	56.02	25.53	38.74
NEGATIVE RSS		2.033	.866	38.64	1915.6	3147.9	43.56	27.82	40.96
RSS		2.033	.928	43.13	1828.6	3891.9	49.79	26.67	39.85

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TABLE 9B

S-I STAGE STATE PARAMETERS AT ØUTBØARD CUT-ØFF

RESULTING FRØM TWØ-SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		X EARTH FIXED (M)	Y EARTH FIXED (M)	Z EARTH FIXED (M)	X-DØT EARTH FIXED (M/SEC)	Y-DØT EARTH FIXED (M/SEC)	Z-DØT EARTH FIXED (M/SEC)
NØMINAL		91064.7	69273.7	382.5	2425.69	1103.64	12.80
NØN-PRØPELLANT MASS	+167 kg	-68.3	-89.6	-.3	-2.18	-1.73	-.01
PRØPELLANT LØADING MASS	-938 kg	-514.6	91.6	-2.3	-7.11	4.51	-.06
THRUST AND FLØW RATE	-1 %	1483.8	-1205.9	8.2	9.94	-33.25	.15
FLØW RATE	+1 %	-2592.6	-747.6	-14.0	-38.37	4.12	-.34
THRUST MISALIGNMENT	.37 deg	-30.4	-12.0	-1669.9	-.18	-.14	-35.53
MIXTURE RATIØ	-.528 %	-512.8	-234.8	-2.4	-11.08	-3.01	-.07
AXIAL DRAG CØEFFICIENT	+10 %	-583.0	-962.3	-3.0	-9.42	-13.05	-.08
HEADWIND		-597.6	-84.0	-263.7	-4.83	-1.39	-3.15
TAILWIND		3365.3	-739.3	927.2	34.09	-8.74	9.04
LEFT CRØSS WIND		-14.5	-218.9	1250.6	1.23	-3.68	12.26
RIGHT CRØSS WIND		842.0	-333.2	-2135.8	9.51	-4.71	-19.75
PØSITIVE RSS		4672.3	1735.1	2283.1	55.61	36.40	38.66
NEGATIVE RSS		3186.5	1929.6	2724.0	43.14	37.94	40.77
RSS		3929.4	1832.3	2503.5	49.37	37.17	39.72

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TABLE 10A

S-IV STAGE STATE PARAMETERS AT GUIDANCE INITIATIØN

RESULTING FRØM S-I STAGE TWØ-SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		PATH ANGLE SPACE FIXED (DEG)	VELØCITY SPACE FIXED (M/SEC)	ALTITUDE (M)	Z EARTH FIXED (M)	INTEGRATED INERTIAL ACCELERATIØNS X1-DØT (M/SEC)	ETA-DØT (M/SEC)	ZETA-DØT (M/SEC)	VEHICLE RADIAL DISTANCE (M)
NØMINAL		70.369	3072.98	89529.3	641.7	2544.33	2545.71	-9.66	6462948
NØN-PRØPELLANT MASS	+167 kg	.019	-2.79	-123.7	-1.2	-2.37	-1.74	-.02	-124
PRØPELLANT LØADING MASS	-938 kg	-.067	-4.24	519.4	8.6	-5.07	1.92	.44	520
THRUST AND FLØW RATE	-1 %	.719	1.56	-1201.4	26.8	14.21	-18.45	.77	-1199
FLØW RATE	+1 %	-.221	-33.57	-333.9	-9.7	-36.23	-7.65	.82	-336
THRUST MISALIGNMENT	.37 deg	.012	.82	-15.1	-2314.6	-.64	-.32	-35.25	-21
MIXTURE RATIØ	-.528 %	.022	-11.10	-101.5	1.4	-10.23	-4.43	.17	-102
AXIAL DRAG CØEFFICIENT	+10 %	.186	-13.57	-1219.3	1.1	-10.02	-13.09	.44	-1220
HEADWIND		.002	-5.11	-123.8	-322.0	-5.14	-1.34	-3.13	-125
TAILWIND		.327	28.48	-821.8	1084.0	33.77	-9.75	8.25	-816
LEFT CRØSS WIND		.069	-.54	-285.5	1471.1	1.07	-3.65	12.09	-282
RIGHT CRØSS WIND		.135	7.75	-396.9	-2494.9	9.01	-4.94	-19.75	-403
PØSITIVE RSS		.858	48.32	1826.8	2949.1	54.53	24.43	38.19	1826
NEGATIVE RSS		.778	38.60	2065.6	3418.5	42.16	27.04	40.55	2063
RSS		.818	43.46	1946.2	3183.8	48.34	25.74	39.37	1945

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TABLE 10B

S-IV STAGE STATE PARAMETERS AT GUIDANCE INITIATIØN

RESULTING FRØM S-I STAGE TWØ-SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		TIME FRØM LIFTØFF (SEC)	X SPACE FIXED (M)	Y SPACE FIXED (M)	Z SPACE FIXED (M)	X-DØT SPACE FIXED (M/SEC)	Y-DØT SPACE FIXED (M/SEC)	Z-DØT SPACE FIXED (M/SEC)
NØMINAL		165.000	206419.2	6459650.6	-712.7	2923.55	939.52	-115.55
NØN-PRØPELLANT MASS	+167 kg	.000	-110.9	-120.4	-.2	-2.37	-1.76	-.02
PRØPELLANT LØADING MASS	-938 kg	.000	236.5	512.4	5.8	-5.09	2.00	.44
THRUST AND FLØW RATE	-1 %	2.000	3917.5	-1325.6	-216.4	13.73	-38.05	.80
FLØW RATE	+1 %	-1.000	-2713.2	-249.9	118.6	-35.97	2.01	.80
THRUST MISALIGNMENT	.37 deg	.000	-47.9	-20.4	-2314.3	-.64	-.32	-35.10
MIXTURE RATIØ	-.528 %	.000	-219.6	-94.8	2.9	-10.23	-4.43	.17
AXIAL DRAG CØEFFICIENT	+10 %	.000	-770.7	-1195.9	8.8	-9.97	-13.27	.44
HEADWIND		.000	-690.3	-103.3	-317.7	-5.06	-1.36	-3.11
TAILWIND		.000	3972.2	-944.3	1063.7	33.41	-9.88	8.16
LEFT CRØSS WIND		.000	10.7	-282.1	1471.8	1.08	-3.69	11.96
RIGHT CRØSS WIND		.000	992.8	-435.6	-2499.5	8.93	-5.00	-19.52
PØSITIVE RSS		2.236	6339.2	1880.5	2952.0	53.99	40.68	37.99
NEGATIVE RSS		2.236	4888.5	2169.8	3430.1	41.76	42.35	40.31
RSS		2.236	5613.8	2025.1	3191.1	47.87	41.51	39.15

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TABLE 11A

S-IV STAGE STATE PARAMETERS AT GUIDANCE INITIATION

RESULTING FROM S-IV STAGE TWO-SIGMA MAGNITUDE PERFORMANCE VARIATIONS

VARIATIONS		PATH ANGLE SPACE FIXED (DEG)	VELOCITY SPACE FIXED (M/SEC)	ALTITUDE (M)	Z EARTH FIXED (M)	INTEGRATED INERTIAL ACCELERATIONS XI-DOT (M/SEC)	ETA-DOT (M/SEC)	ZETA-DOT (M/SEC)	VEHICLE RADIAL DISTANCE (M)
NOMINAL		70.369	3072.98	89529.3	641.7	2544.33	2545.71	-9.66	6462948
NON-PROPELLANT MASS	+37 kg	.000	-.08	-31.8	-.3	-.08	-.03	-.02	-31
PROPELLANT LOADING MASS	-605 kg	-.213	7.25	921.4	-62.6	3.33	13.05	-.44	921
THRUST AND FLOW RATE	-0.5 %	.001	-.29	-32.3	.8	-.26	-.15	.04	-32
FLOW RATE	+0.5 %	.000	.18	-30.7	1.0	.17	.04	.05	-30
THRUST MISALIGNMENT	.41 deg	.001	.18	-31.4	-7.7	.14	.01	-1.11	-31
MIXTURE RATIO	+8.5 %	-.003	1.63	4.9	.6	1.51	.66	.02	5
POSITIVE RSS		.213	7.44	923.6	63.0	3.67	13.07	1.20	923
NEGATIVE RSS		.213	7.44	923.6	63.0	3.67	13.07	1.20	923
RSS		.213	7.44	923.6	63.0	3.67	13.07	1.20	923

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TABLE 11B

S-IV STAGE STATE PARAMETERS AT GUIDANCE INITIATIØN

RESULTING FRØM S-IV STAGE TWØ-SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		TIME FRØM LIFTØFF (SEC)	X SPACE FIXED (M)	Y SPACE FIXED (M)	Z SPACE FIXED (M)	X-DØT SPACE FIXED (M/SEC)	Y-DØT SPACE FIXED (M/SEC)	Z-DØT SPACE FIXED (M/SEC)	F/M (M/SEC SQ)
NØMINAL		165.000	206419.2	6459650.6	-712.7	2923.55	939.52	-115.55	6.70
NØN-PRØPELLANT MASS	+37 kg	.000	-.3	-31.3	-1.0	-.07	-.04	-.02	.00
PRØPELLANT LØADING MASS	-605 kg	.000	-65.2	923.7	-64.7	3.35	13.16	-.44	.07
THRUST AND FLØW RATE	-0.5 %	.000	-.4	-31.8	.1	-.26	-.15	.04	-.03
FLØW RATE	+0.5 %	.000	- 2.7	+30.4	-.2	-.17	- .04	-.05	.00
THRUST MISALIGNMENT	.41 deg	.000	2.2	-31.0	-8.4	.14	.00	-1.11	.00
MIXTURE RATIØ	+8.5 %	.000	10.7	4.6	.5	1.51	.66	.02	.14
PØSITIVE RSS		.000	66.2	925.8	65.2	3.69	13.18	1.20	.02
NEGATIVE RSS		.000	66.2	925.8	65.2	3.69	13.18	1.20	.02
RSS		.000	66.2	925.8	65.2	3.69	13.18	1.20	.02

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TABLE 12A

S-IV STAGE STATE PARAMETERS AT GUIDANCE CUT-ØFF SIGNAL

RESULTING FRØM S-I STAGE TWØ-SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		TIME FRØM LIFTØFF (SEC)	PATH ANGLE SPACE FIXED (DEG)	VELØCITY SPACE FIXED (M/SEC)	ALTITUDE (M)	RANGE (M)	RESIDUAL PRØPELLANT MASS (KG)	VELØCITY ØVER CIRCULAR (M/SEC)	VEHICLE RADIAL DISTANCE (M)
NØMINAL		618.968	89.954	7806.00	185536.4	2073448.4	929.86	11.41	6560744
NØN-PRØPELLANT MASS	+167 kg	.175	-.001	.00	-3.6	-285.8	-16.41	-.00	-4
PRØPELLANT LØADING MASS	-938 kg	-.074	-.018	-.00	-50.3	-1028.4	-25.86	-.03	-51
THRUST AND FLØW RATE	-1 %	1.844	.067	.00	173.5	1813.8	-39.37	.11	176
FLØW RATE	+1 %	.689	-.059	.00	-188.5	-5921.2	-194.70	-.11	-194
THRUST MISALIGNMENT	.37 deg	.651	-.017	.00	-36.8	-500.0	-60.84	-.02	-37
MIXTURE RATIØ	-.528 %	.529	-.012	.00	-41.5	-1525.4	-68.18	-.02	-43
AXIAL DRAG CØEFFICIENT	+10 %	.974	.009	-.00	16.1	-1699.3	-91.08	.01	15
HEADWIND		.336	.002	.00	-30.7	-1117.9	-31.48	-.02	-32
TAILWIND		-1.547	.013	.00	304.9	6374.1	144.86	.19	310
LEFT CRØSS WIND		.046	.005	.00	31.4	47.5	-4.30	.02	31
RIGHT CRØSS WIND		.072	-.006	.00	73.8	1355.9	-6.75	.05	76
PØSITIVE RSS		2.384	.094	.00	413.4	9350.1	279.33	.25	421
NEGATIVE RSS		2.820	.093	.00	269.2	6797.4	241.03	.16	275
RSS		2.602	.094	.00	341.3	8073.7	260.18	.21	348

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TABLE 12B

S-IV STAGE STATE PARAMETERS AT GUIDANCE CUT-ØFF SIGNAL

RESULTING FRØM S-I STAGE TWØ-SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		INTEGRATED INERTIAL ACCELERATIØNS X1-DØT (M/SEC)	ETA-DØT (M/SEC)	ZETA-DØT (M/SEC)	Z EARTH FIXED (M)	LØNGITUDE + WEST ØF GREENWICH (DEG)	GEØDETIC LATITUDE + NØRTH (DEG)	Z-DOT EARTH FIXED (M/SEC)
NØMINAL		7627.67	2965.17	-.16	48833.7	61.28135	21.917376	221.36
NØN-PRØPELLANT MASS	+167 kg	.24	2.15	.00	12.3	.00259	.000926	.05
PRØPELLANT LØADING MASS	-938 kg	.85	2.57	.00	-27.1	.00904	.003896	.01
THRUST AND FLØW RATE	-1 %	-1.38	8.37	.00	217.8	-.01527	-.008224	.40
FLØW RATE	+1 %	4.07	21.26	.00	-39.7	.05248	.021507	.29
THRUST MISALIGNMENT	.37 deg	1.65	8.84	-.00	257.9	.00546	-.000270	.66
MIXTURE RATIØ	-.528 %	1.26	8.48	.00	24.7	.01365	.005264	.17
AXIAL DRAG CØEFFICIENT	+10 %	.79	11.06	.00	67.0	.01536	.005554	.25
HEADWIND		.12	4.30	-.00	42.5	.01010	.003663	.15
TAILWIND		-1.15	-22.86	.00	-132.7	-.05717	-.021764	-.61
LEFT CRØSS WIND		-.13	-.01	.00	-130.5	-.00094	.000873	-.28
RIGHT CRØSS WIND		.77	.14	-.00	265.8	-.01101	-.006974	.52
PØSITIVE RSS		4.98	28.71	.00	440.4	.06025	.024880	1.03
NEGATIVE RSS		5.05	36.44	.00	395.2	.08318	.033573	1.10
RSS		5.02	32.58	.00	417.8	.07171	.029227	1.07

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TABLE 13A

S-IV STAGE STATE PARAMETERS AT GUIDANCE CUT-ØFF SIGNAL

RESULTING FRØM S-IV STAGE TWØ SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		TIME FRØM LIFTØFF (SEC)	PATH ANGLE SPACE FIXED (DEG)	VELØCITY SPACE FIXED (M/SEC)	ALTITUDE (M)	RANGE (M)	RESIDUAL PRØPELLANT MASS (KG)	VELØCITY ØVER CIRCULAR (M/SEC)	VEHICLE RADIAL DISTANCE (M)
NØMINAL		618.968	89.954	7806.00	185536.4	2073448.5	929.86	11.41	6560744
NON-PROPELLANT MASS	+37 kg	.309	.000	-.00	3.6	1184.9	-28.93	-.00	5
PROPELLANT LOADING MASS	-605 kg	-5.515	-.008	-.00	-178.5	-19421.8	-88.05	-.12	-198
THRUST AND FLOW RATE	-0.5 %	2.477	.001	-.00	-20.5	9662.5	-29.29	-.01	-10
FLOW RATE	+0.5 %	-1.149	.001	.00	-124.3	-5746.1	-94.53	-.07	-130
THRUST MISALIGNMENT	.41 deg	-.006	-.001	-.00	-23.7	49.0	.55	-.02	-24
MIXTURE RATIO	+8.5 %	-9.013	.004	-.00	-454.3	-36672.4	-52.08	-.29	-491
PØSITIVE RSS		10.918	.009	.00	504.7	43010.0	145.25	.33	546
NEGATIVE RSS		10.918	.009	.00	504.7	43010.0	145.25	.33	546
RSS		10.918	.009	.00	504.7	43010.0	145.25	.33	546

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TABLE 13B

S-IV STAGE STATE PARAMETERS AT GUIDANCE CUT-ØFF SIGNAL

RESULTING FRØM S-IV STAGE TWØ SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		INTEGRATED INERTIAL ACCELERATIØNS X1-DØT (M/SEC)	ETA-DØT (M/SEC)	ZETA-DØT (M/SEC)	Z EARTH FIXED (M)	LØNGITUDE + WEST ØF GREENWICH (DEG)	GEØDETIC LATITUDE + NØRTH (DEG)	Z-DOT EARTH FIXED (M/SEC)
NØMINAL		7627.67	2965.17	-.16	48833.7	61.28135	21.917377	221.36
NON-PROPELLANT MASS	+37 kg	.23	1.16	.00	48.6	-.00994	-.006058	.09
PROPELLANT LOADING MASS	-605 kg	-4.46	-23.59	-.00	-865.6	.16930	.076396	-1.68
THRUST AND FLOW RATE	-0.5 %	1.97	9.27	.00	405.7	-.08385	-.039307	.76
FLOW RATE	+0.5 %	-.78	-2.91	.00	-211.2	.04983	.023697	-.36
THRUST MISALIGNMENT	.41 deg	.05	.07	.00	-143.4	-.00060	-.000457	.08
MIXTURE RATIO	+8.5 %	-7.20	-32.80	-.00	-1505.1	.32033	.143059	-2.85
PØSITIVE RSS		8.73	41.57	.01	1801.9	.37535	.168658	3.41
NEGATIVE RSS		8.73	41.57	.01	1801.9	.37535	.168658	3.41
RSS		8.73	41.57	.01	1801.9	.37535	.168658	3.41

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TABLE 14A

S-IV STAGE ØRBITAL INSERTIØN STATE PARAMETERS

RESULTING FRØM S-I STAGE TWØ-SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		TIME FRØM LIFTØFF (SEC)	PATH ANGLE SPACE FIXED (DEG)	VELØCITY SPACE FIXED (M/SEC)	ALTITUDE (M)	RANGE (M)	RESIDUAL PRØPELLANT MASS (KG)	VELØCITY ØVER CIRCULAR (M/SEC)	VEHICLE RADIAL DISTANCE (M)
NØMINAL		628.968	89.950	7807.55	185532.3	2145381.3	929.86	12.99	6560810
NØN-PRØPELLANT MASS	+167 kg	.175	-.001	.00	-2.8	-285.7	-16.41	.00	-3
PRØPELLANT LØADING MASS	-938 kg	-.074	-.018	-.03	-26.2	-1028.2	-25.86	-.04	-27
THRUST AND FLØW RATE	-1 %	1.844	.067	.12	82.6	1813.0	-39.37	.17	85
FLØW RATE	+1 %	.689	-.058	-.07	-108.6	-5919.8	-194.70	-.14	-114
THRUST MISALIGNMENT	.37 deg	.651	-.017	-.02	-13.4	-499.7	-60.84	-.03	-13
MIXTURE RATIØ	-.528 %	.529	-.012	-.01	-25.2	-1524.9	-68.18	-.02	-27
AXIAL DRAG CØEFFICIENT	+10 %	.974	.009	.02	4.5	-1699.3	-91.08	.03	3
HEADWIND		.336	.002	.01	-33.6	-1117.4	-31.48	-.01	-35
TAILWIND		-1.547	.013	.01	287.2	6370.8	144.86	.18	293
LEFT CRØSS WIND		.046	.005	.01	24.6	47.3	-4.30	.02	24
RIGHT CRØSS WIND		.072	-.006	-.01	81.5	1355.1	-6.75	.04	83
PØSITIVE RSS		2.384	.094	.14	331.5	9346.5	279.33	.30	339
NEGATIVE RSS		2.820	.093	.14	145.9	6795.7	241.03	.23	152
RSS		2.602	.094	.14	238.7	8071.1	260.18	.26	246

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TABLE 14B

S-IV STAGE ØRBITAL INSERTIØN STATE PARAMETERS

RESULTING FRØM S-I STAGE TWØ-SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		INTEGRATED INERTIAL ACCELERATIØNS X1-DØT (M/SEC)	ETA-DØT (M/SEC)	ZETA-DØT (M/SEC)	Z EARTH FIXED (M)	LØNGITUDE + WEST ØF GREENWICH (DEG)	GEØDETIC LATITUDE + NØRTH (DEG)	Z-DOT EARTH FIXED (M/SEC)
NØMINAL		7629.25	2964.84	-.16	51064.4	60.65209	21.640593	224.72
NØN-PRØPELLANT MASS	+167 kg	.24	2.15	.00	12.8	.00258	.000932	.05
PRØPELLANT LØADING MASS	-938 kg	.86	2.57	.00	-26.9	.00900	.003932	.01
THRUST AND FLØW RATE	-1 %	-1.38	8.35	.00	221.8	-.01518	-.008319	.39
FLØW RATE	+1 %	4.09	21.25	.00	-36.8	.05228	.021690	.29
THRUST MISALIGNMENT	.37 deg	1.66	8.84	-.00	264.4	.00547	-.000300	.65
MIXTURE RATIØ	-.528 %	1.27	8.48	.00	26.4	.01361	.005304	.17
AXIAL DRAG CØEFFICIENT	+10 %	.80	11.05	.00	69.5	.01532	.005594	.25
HEADWIND		.12	4.30	-.00	43.9	.01007	.003690	.14
TAILWIND		-1.16	-22.84	.00	-138.9	-.05696	-.021925	-.62
LEFT CRØSS WIND		-.13	-.01	.00	-133.3	-.00095	.000893	-.27
RIGHT CRØSS WIND		.77	.14	-.00	271.0	-.01093	-.007054	.52
PØSITIVE RSS		5.00	28.69	.00	449.7	.06002	.025098	1.02
NEGATIVE RSS		5.07	36.42	.00	404.9	.08286	.033852	1.10
RSS		5.04	32.55	.00	427.3	.07144	.029475	1.06

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TABLE 15A

S-IV STAGE ØRBITAL INSERTIØN STATE PARAMETERS

RESULTING FRØM S-IV STAGE TWØ SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		TIME FRØM LIFTØFF (SEC)	PATH ANGLE SPACE FIXED (DEG)	VELØCITY SPACE FIXED (M/SEC)	ALTITUDE (M)	RANGE (M)	RESIDUAL PRØPELLANT MASS (KG)	VELØCITY ØVER CIRCULAR (M/SEC)	VEHICLE RADIAL DISTANCE (M)
NØMINAL		628.968	89.950	7807.55	185532.3	2145381.3	929.86	12.99	6560810
NON-PROPELLANT MASS	+37 kg	.309	.000	-.00	3.1	1184.8	-28.93	-.00	5
PROPELLANT LOADING MASS	-605 kg	-5.515	-.008	.04	-167.8	-19420.8	-88.05	-.07	-187
THRUST AND FLOW RATE	-0.5 %	2.477	.001	-.00	-21.6	9662.6	-29.14	-.01	-12
FLOW RATE	+0.5 %	-1.149	.001	.01	-125.1	-5744.6	-94.68	-.07	-131
THRUST MISALIGNMENT	.41 deg	-.006	-.001	-.01	-21.8	49.2	.55	-.02	-22
MIXTURE RATIO	+8.5 %	-9.013	.004	.02	-460.5	-36667.4	-52.76	-.28	-497
PØSITIVE RSS		10.918	.009	.05	506.8	43005.1	145.55	.30	548
NEGATIVE RSS		10.918	.009	.05	506.8	43005.1	145.55	.30	548
RSS		10.918	.009	.05	506.8	43005.1	145.55	.30	548

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TABLE 15B

S-IV STAGE ØRBITAL INSERTIØN STATE PARAMETERS

RESULTING FRØM S-IV STAGE TWØ SIGMA MAGNITUDE PERFØRMANCE VARIATIØNS

VARIATIØNS		INTEGRATED INERTIAL ACCELERATIØNS X1-DØT (M/SEC)	ETA-DØT (M/SEC)	ZETA-DØT (M/SEC)	Z EARTH FIXED (M)	LØNGITUDE + WEST ØF GREENWICH (DEG)	GEØDETIC LATITUDE + NØRTH (DEG)	Z-DOT EARTH FIXED (M/SEC)
NØMINAL		7629.25	2964.84	-.16	51064.4	60.65209	21.640593	224.72
NON-PROPELLANT MASS	+37 kg	.23	1.16	.00	49.5	-.00989	-.006099	.08
PROPELLANT LOADING MASS	-605 kg	-4.41	-23.62	-.00	-882.4	.16855	.077188	-1.66
THRUST AND FLOW RATE	-0.5 %	1.97	9.27	.00	413.2	-.08349	-.039690	.75
FLOW RATE	+0.5 %	.78	2.91	.00	214.8	-.04961	-.023909	.35
THRUST MISALIGNMENT	.41 deg	.05	.07	.00	-142.6	-.00060	-.000462	.08
MIXTURE RATIO	+8.5 %	-7.18	-32.79	-.00	-1533.4	.31892	.144518	-2.80
PØSITIVE RSS		8.69	41.58	.01	1835.6	.37370	.170375	3.36
NEGATIVE RSS		8.69	41.58	.01	1835.6	.37370	.170375	3.36
RSS		8.69	41.58	.01	1835.6	.37370	.170375	3.36

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TABLE 16

PERIGEE AND APOGEE VARIATIONS
DUE TO S-I STAGE PERFORMANCE VARIATION OF A TWO-SIGMA MAGNITUDE

VARIATIONS		PERIGEE (M)	APOGEE (M)
NOMINAL		181916.	227301.
NON-PROPELLANT MASS	+167 kg	-354.	169.
PROPELLANT LOADING MASS	-938 kg	-1048.	667.
THRUST AND FLOW RATE	-1 %	726.	-163.
FLOW RATE	+1 %	-3257.	2378.
THRUST MISALIGNMENT	.37 deg	-1004.	711.
MIXTURE RATIO	-.528 %	-796.	479.
AXIAL DRAG COEFFICIENT	+10 %	-64.	-21.
HEADWIND		-299.	11.
TAILWIND		345.	688.
LEFT CROSS WIND		-153.	102.
RIGHT CROSS WIND		442.	571.
POSITIVE RSS		3794.	2776.
NEGATIVE RSS		3768.	2626.
RSS		3781.	2701.

PERIGEE AND APOGEE VARIATIONS
DUE TO S-IV STAGE PERFORMANCE VARIATION OF A TWO-SIGMA MAGNITUDE

VARIATIONS		PERIGEE (M)	APOGEE (M)
NOMINAL		181916.	227301.
NON-PROPELLANT MASS	+37 kg	24.	-18.
PROPELLANT LOADING MASS	-605 kg	-446.	-165.
THRUST AND FLOW RATE	-0.5 %	17.	-68.
FLOW RATE	+0.5 %	-184.	-697.
THRUST MISALIGNMENT	.41 deg	24.	-18.
MIXTURE RATIO	+8.5 %	-617.	-1564.
POSITIVE RSS		785.	1722.
NEGATIVE RSS		785.	1722.
RSS		785.	1722.

Apogee and perigee altitudes are referenced to a spherical earth of radius 6378.165 km.

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Table 17

PERFORMANCE PARTIALS APPLICABLE AT S-I STAGE OUTBOARD CUTOFF

INDEPENDENT VARIABLE \ DEPENDENT VARIABLE	Units	Time	Path Angle	Velocity	Altitude	Range	X (E.F.)	Y (E.F.)	Z (E.F.)	$\dot{X}$ (E.F.)	$\dot{Y}$ (E.F.)	$\dot{Z}$ (E.F.)
	Units →	sec	deg	m/sec	m	m	m	m	m	m/sec	m/sec	m/sec
NON-PROPELLANT MASS	100 lbs wt	0.0	.005	-.7	-25.	-18.	-18.5	-24.3	0	-.59	-.47	0
PROPELLANT LOADING MASS	100 lbs wt	.017	.007	.2	0	25.	24.9	-4.4	0	.34	-.22	0
THRUST AT ISP = CONSTANT	+1%	-1.423	-.728	4.6	1,185.	-1,485.	-1,484.	1,206.	-8.	-9.94	33.25	-.15
FLOW RATE	+1%	-1.395	-.407	-33.1	-784.	-2,553.	-2,593.	-748.	-14.	-38.37	4.12	-.34
THRUST MISALIGNMENT	1 deg*	0	.011	-.4	-33.	-46.	-82.	-32.	-4,509.	-.49	-.38	-95.94
MIXTURE RATIO	+1%	.379	.068	21.5	458.	954.	971.	447.	5.	20.98	5.70	.13
DRAG COEFFICIENT	+1%	0	.018	-1.4	-97.	-56.	-58.	-96.	0	-.94	-1.31	0

*Applied Normal to Flight Plane

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Table 18

PERFORMANCE PARTIALS APPLICABLE AT S-IV STAGE GUIDANCE CUTOFF SIGNAL AND ORBITAL INSERTION

	INDEPENDENT VARIABLE \ DEPENDENT VARIABLE	Units	Time	Path Angle	Altitude	Range	Propellant Reserve (Weight)	Velocity Exceeding Circular	Integrated Inertial Accelerations $\dot{\xi}$	$\dot{\eta}$	$\dot{\zeta}$	Cross-range (E.F.)	Crossrange Velocity (E.F.)
		Units→	sec	deg	m	m	lbs	m/sec	m/sec	m/sec	m/sec	m	m/sec
S-I STAGE VARIATIONS	NON-PROPELLANT MASS	100 lbs wt	.047	.000	-1.	-78.	-10.	0.0	.07	.58	0.0	3.	.01
	PROPELLANT LOADING MASS	100 lbs wt	.004	.001	2.	50.	3.	0.0	0.0	-.12	0.0	1.	0.0
	THRUST AT ISP = CONSTANT	+1%	-1.844	-.067	-174.	-1,814.	87.	-.11	1.38	-8.37	0.0	-218.	-.40
	FLOW RATE	+1%	.689	-.059	-189.	-5,921.	-429.	-.11	4.07	21.26	0.0	-40.	.29
	THRUST MISALIGNMENT	1 deg*	1.759	-.046	-99.	-1,351.	-363.	-.05	4.46	23.89	0.0	697.	1.78
	MIXTURE RATIO	+1%	-1.002	.023	79.	2,889.	285.	.04	-2.39	-16.06	0.0	-47.	-.32
	DRAG COEFFICIENT	+1%	.097	.001	2.	-170.	-20.	0.0	.08	1.11	0.0	7.	.03
S-IV STAGE VARIATIONS	NON-PROPELLANT MASS	100 lbs wt	.381	0.0	4.	1,463.	79.	0.0	.28	1.43	0.0	60.	.11
	PROPELLANT LOADING MASS	100 lbs wt	.414	.001	13.	1,457.	15.	.01	.33	1.77	0.0	65.	.13
	THRUST AT ISP = CONSTANT	+1%	-4.940	-.002	41.	-19,325.	129.	.02	-3.94	-18.54	0.0	-811.	-1.52
	FLOW RATE	+1%	-2.298	.002	-249.	-11,492.	417.	-.14	-1.56	-5.82	0.0	-422.	-.72
	THRUST MISALIGNMENT	1 deg*	-.015	-.002	-58.	120.	3.	-.05	.12	.17	0.0	-350.	.20
	MIXTURE RATIO	+1%	-1.060	0.0	-53.	-4,314.	-14.	-.03	-.85	-3.86	0.0	-177.	-.34

*Applied Normal to Flight Plane

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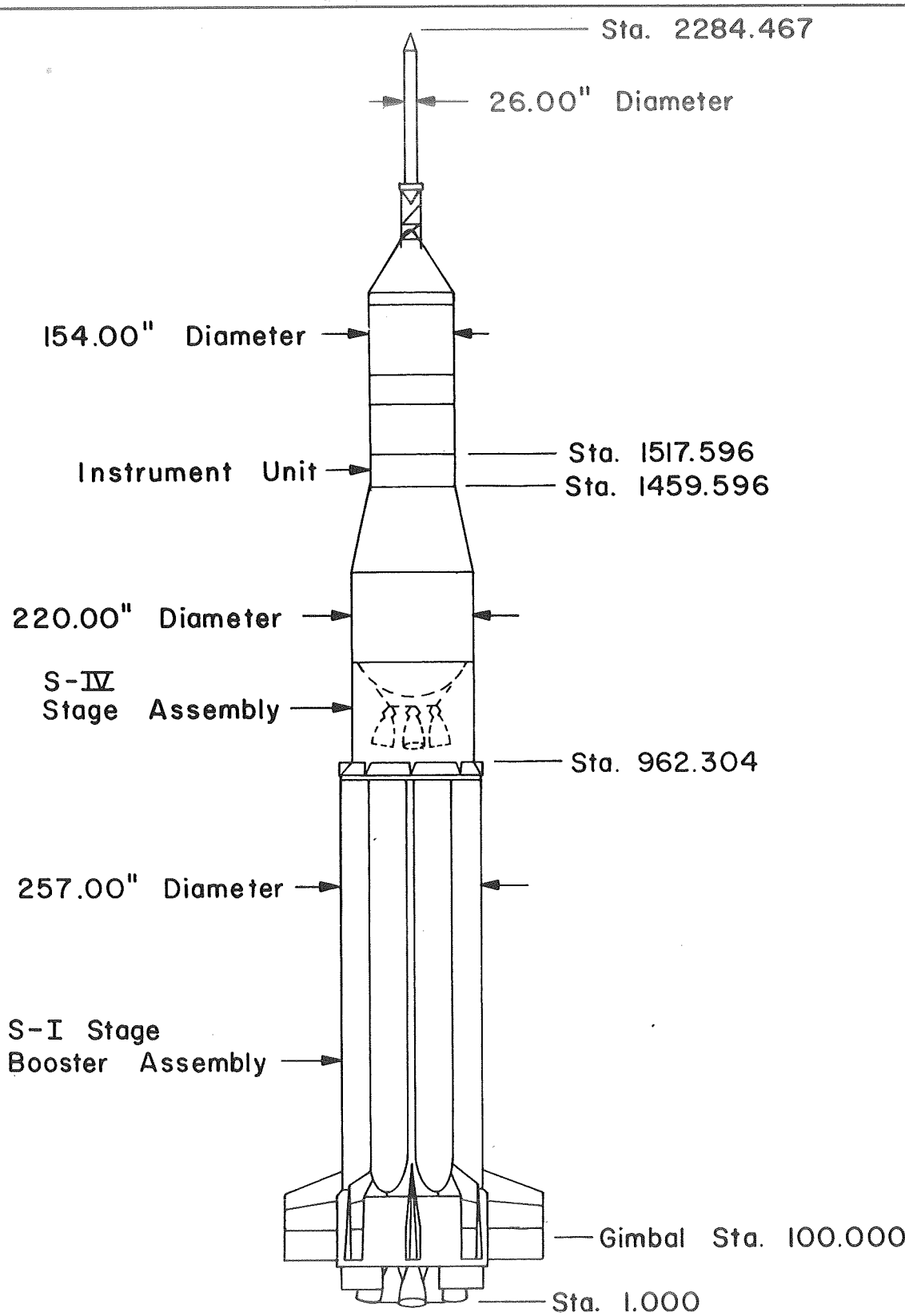

FIG. 1 SA-7. CONFIGURATION

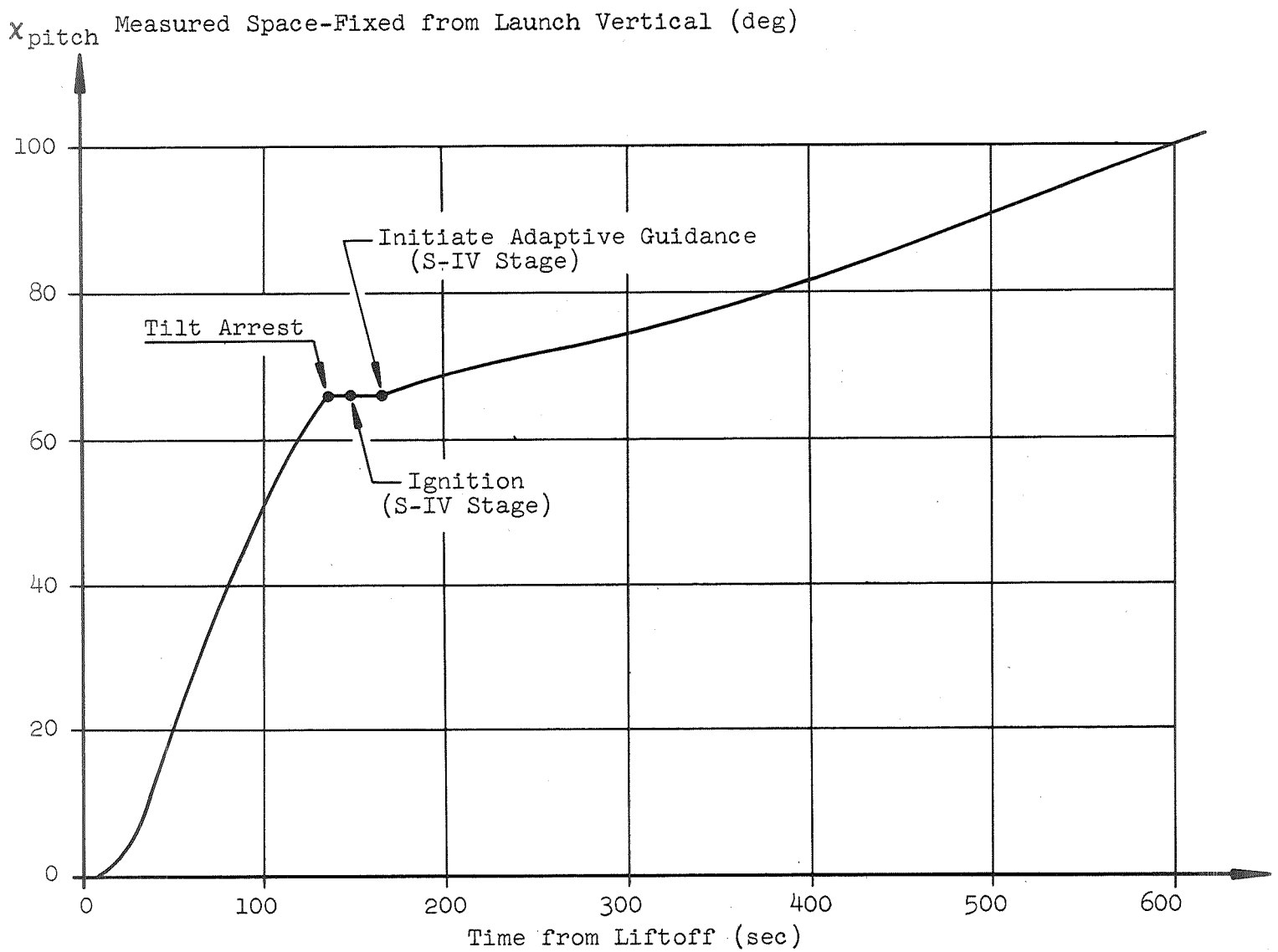

FIG. 2 PITCH TILT PROGRAM FOR SATURN I SA-7

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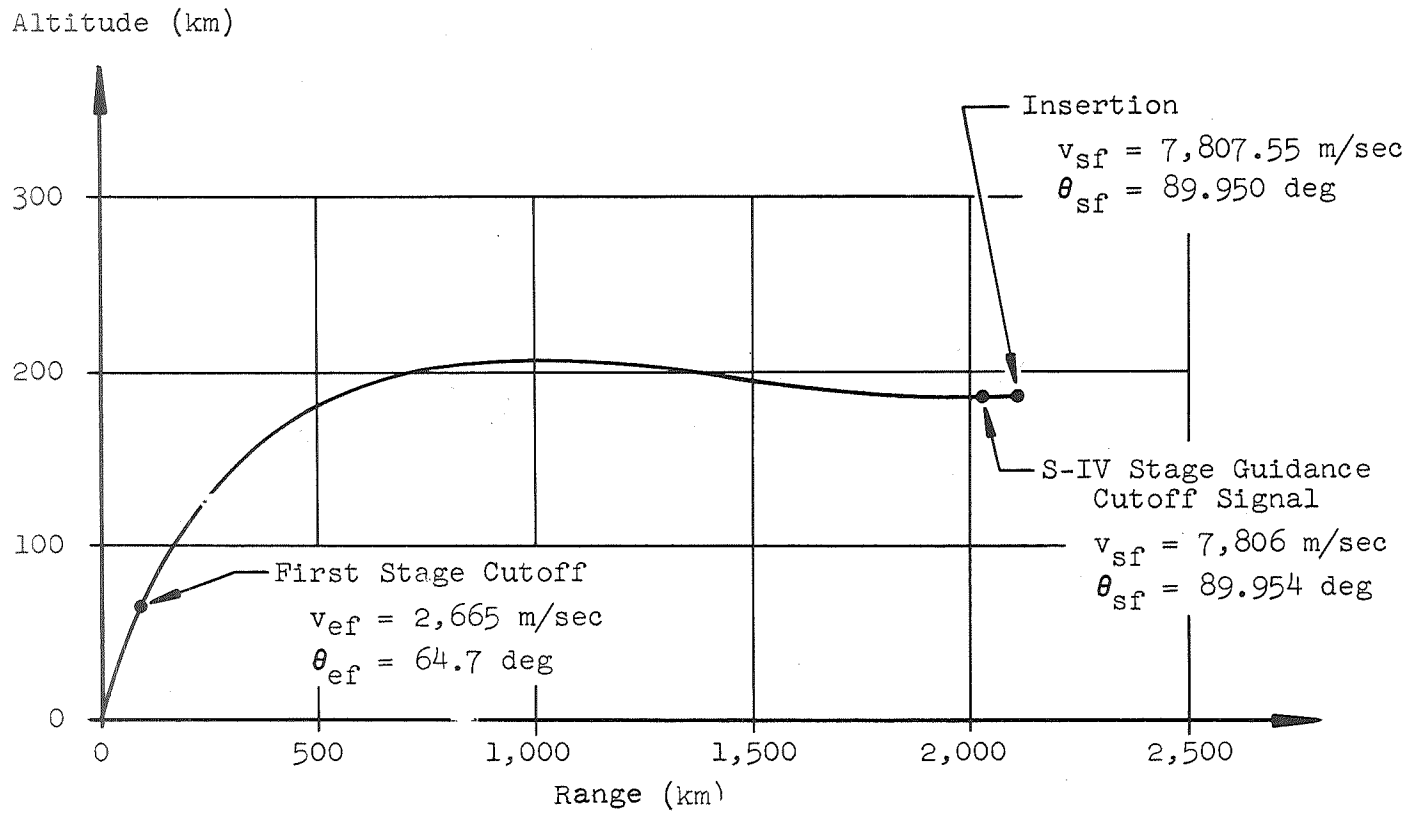

FIG. 3 POWERED FLIGHT TRAJECTORY FOR SATURN I SA-7

(Azimuth = 105 deg)

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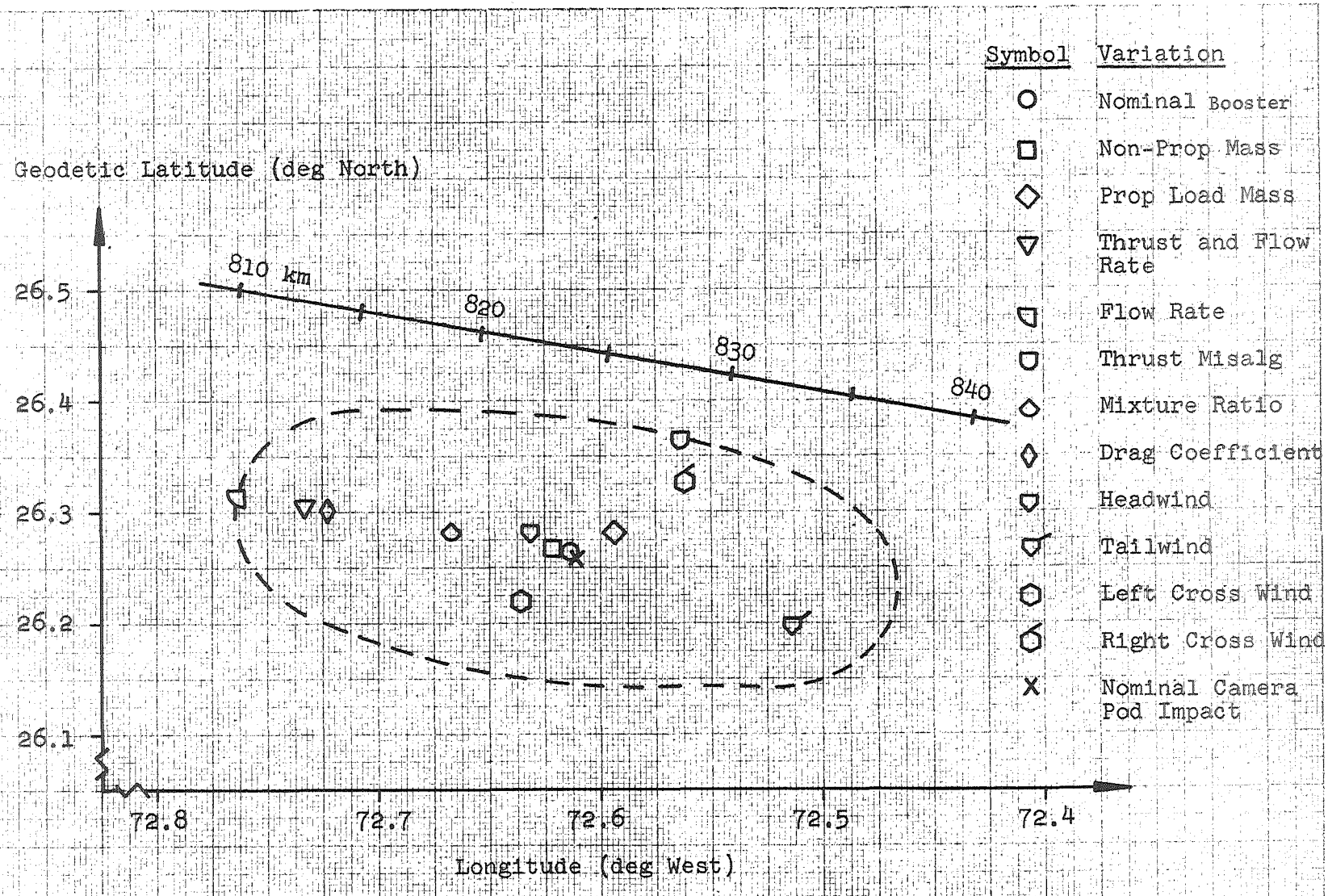

FIG. 4 DISPERSION ABOUT NOMINAL BOOSTER IMPACT POINT (BALLISTIC IMPACTS)

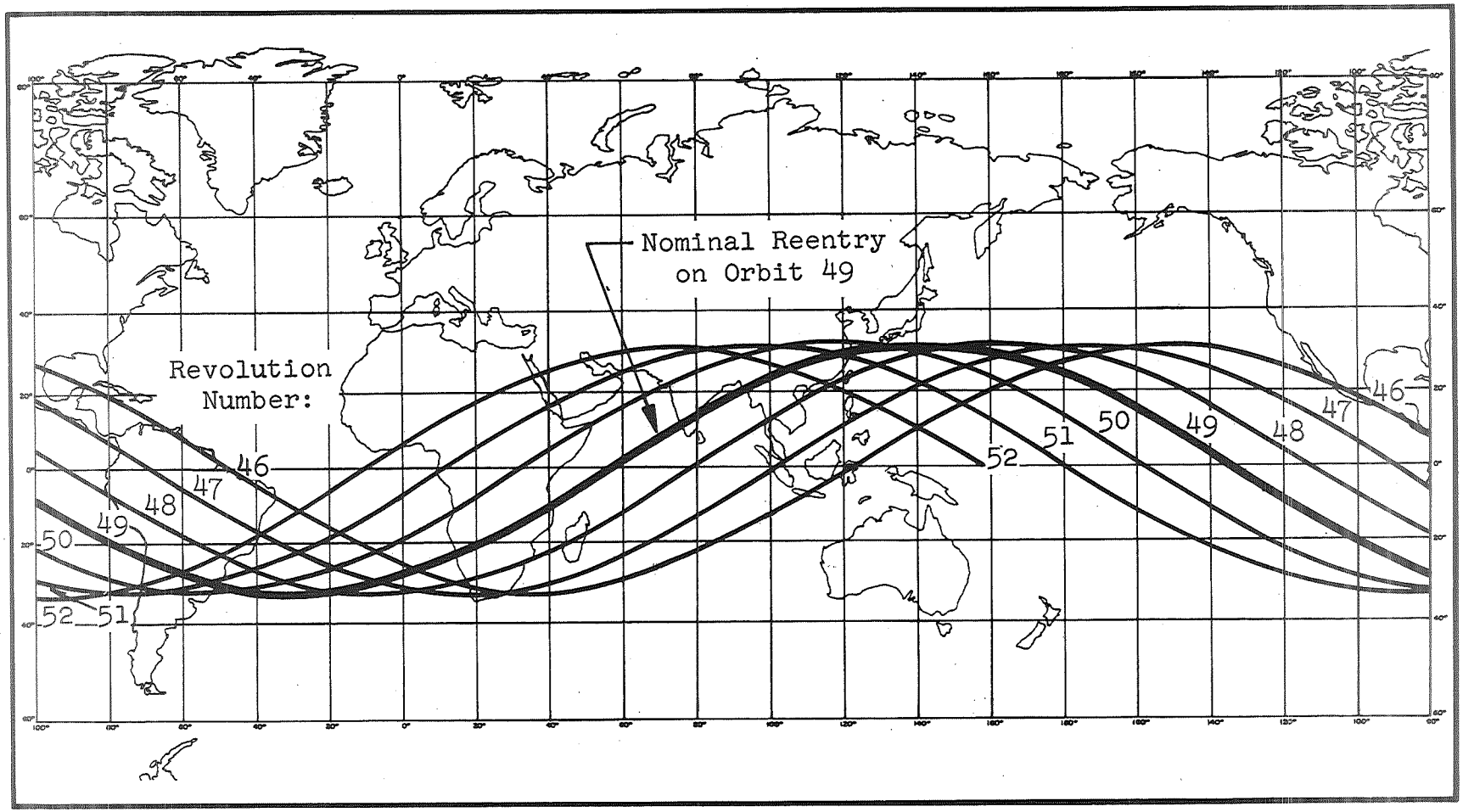

FIG. 5 SA-7 NOMINAL ORBITAL REENTRY

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APPROVAL NASA TM X-53120

FINAL PREDICTED TRAJECTORY AND DISPERSION STUDY
FOR SATURN I VEHICLE SA-7

By Jerry D. Weiler and Onice M. Hardage, Jr.

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be CONFIDENTIAL.

This document has also been reviewed and approved for technical accuracy.

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