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SA-8 OPERATIONAL TRAJECTORY

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ABSTRACT

This report presents the operational predicted trajectory for Saturn I vehicle SA-8 to be flown over the Atlantic Missile Range. Included is a discussion of the vehicle and mission objectives, the trajectory shaping and constraints and a brief description of the vehicle. Wind limit criteria and range safety aspects are also summarized.

A successful flight will insert the depleted S-IV stage and payload into an orbit with perigee and apogee altitudes of 510 km and 754 km, respectively. This orbit has a nominal lifetime of 1200 days.

The payload consists of an Apollo boilerplate (BP-26) and a Meteoroid Technology Satellite (Pegasus). BP-26 is used to simulate the characteristics of an Apollo spacecraft whose ultimate mission will be a manned lunar landing and return to earth. After insertion into orbit, Pegasus will be exposed and, after wing deployment, will transmit micrometeoroid data to earth upon telemetered command.

NASA-GEORGE C. MARSHALL SPACE FLIGHT CENTER

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SA-8 OPERATIONAL TRAJECTORY

SUMMARY

The trajectory for SA-8 was optimized to insert the S-IV stage and payload into an elliptical orbit with perigee and apogee altitudes of 510 km and 754 km, respectively. This orbit has a predicted nominal lifetime of 1200 days.

The S-I stage pitch program was shaped to minimize the angle of attack through the region of high dynamic pressure under non-wind conditions. The S-IV stage uses the Iterative Guidance Mode (IGM) to guide an optimum path in the pitch plane and the delta minimum mode for cross range guidance.

The S-I booster will propel the vehicle to an altitude of 89 km with a range of 81 km. After separation of the two stage vehicle and approximately 2 sec of ullage rocket operation, the S-IV main stage will ignite. The S-IV main engines will burn until the guidance computer initiates Guidance Cutoff Signal (GCS), which occurs when the inertial velocity reaches 7672.06 m/s. Then, after 10 seconds to allow thrust decay, orbital insertion occurs at 638.58 sec from liftoff. Conditions at time of insertion: A velocity of 7675.18 m/s; a path angle (inertially referenced from the local vertical) of 90.000 deg; initial perigee altitude of 506.5 km and a corresponding apogee altitude of 751.2 km when referenced to a spherical earth of 6378.165 km.

The earliest S-I inboard engine failure which still results in a guidance cutoff is 90 seconds after liftoff. An outboard failure will not permit a guidance cutoff, but failure after 140 seconds from liftoff will result in at least a circular orbit (approximately 510 km altitude).

SECTION I. INTRODUCTION

The Block II vehicle SA-8, consisting of two live stages, Instrument Unit, Apollo Boilerplate, and Pegasus Payload (Figure 1), is scheduled to ascend from Launch Complex 37B, Atlantic Missile Range Facilities in late May. SA-8 will have a launch azimuth of 90 deg East-of-North (105 deg East-of-North flight azimuth).

This trajectory is based on propulsion (References 1 and 2) and mass (Reference 3) data provided by P&VE Laboratory. The first stage will be propelled by eight Rocketdyne H-1 engines providing a total thrust of 1.5 million pounds. Six 15,000 pound-thrust, Pratt & Whitney, RL10A-3 engines power the S-IV stage during flight. The S-I stage measures 6.5 meters in diameter and 24.5 meters in length. The S-IV stage is basically a 5.6 meter-diameter cylinder measuring 12.5 meters in length. With the Instrument Unit, Payload and Launch Escape System (LES), the total vehicle configuration stands approximately 57.3 meters and has a liftoff mass of 1,129,768 pounds. Found in Reference 4 is a more complete description of the vehicle and payload (see Figure 2). There will be no onboard camera coverage of separation.

Lifetime information presented in this report was obtained from the Operations Studies Branch, R-AERO-FO. The structurally imposed wind limits and Pegasus angular rate limitations summarized in Appendices A and B are provided by R-AERO-FMS. The Range Safety Summary, Appendix C, is provided by R-AERO-FMR.

SECTION II. DESCRIPTION

The SA-8 vehicle will lift off from Pad 37B, rising vertically for 9 sec in order to clear the launch facilities and then simultaneously begin its pitch program and roll maneuver. The roll rate will be nominally one deg per second.

The first stage trajectory was shaped to minimize aerodynamic moments during the period of highest dynamic pressure. The tilt program is not biased for wind as the launch date is in a low wind period. The entire flight program was optimized to attain the maximum performance while achieving the desired orbital mission objectives and constraints which, briefly are:

1. Guarantee a one-year lifetime
2. Guarantee a guidance cutoff
3. Limit the apogee altitude to approximately 750 km
4. Have a minimum of residual propellant at guidance cutoff.

A tilt arrest of 52.45 deg is programmed at 138 sec after liftoff to ensure ample damping time for various sloshing and transient motions in order to avoid premature cutoff and separation sequences. The separation sequence of events is commanded from a timer which is initiated by propellant level sensors (Reference 5).

After separation, tilt arrest is continued until 168 sec after liftoff, allowing sufficient time for the LES tower and ullage casings to be jettisoned. The Launch Escape System has only one active motor, the jettison motor. This motor provides the capability of separating the LES from the Command Module (CM) during an abort mode or during normal flight.

The Saturn guidance system, Iterative Guidance Mode (IGM), implemented approximately 17 sec after separation, will guide the S-IV vehicle to the desired terminal conditions. IGM terminal conditions are given in Appendix D. Guidance Cutoff Signal (GSC) is sent by the onboard computer (ASC-15) when the inertial velocity reaches 7672.06 m/s.

Orbital insertion is defined as 10 sec after GCS. Insertion conditions are given in Table 1. After GCS, the S-IV vehicle undergoes a 180 sec venting period to reduce LH_2 residuals. At this time the blowdown non-propulsive vents are closed and, one sec later, the Pegasus S-IV combination separates from the Apollo Boilerplate (809.58 sec flight time). The Pegasus satellite begins its wing deployment 60 sec after separation and terminates approximately 60 sec later (929.58 sec after liftoff).

The complete flight profile is presented in Figure 3 with the nominal pitch tilt program graphically presented in Figure 4.

SECTION III. RESULTS

The SA-8 fact sheet found in Table I contains a summary of the vehicle characteristics, trajectory history and insertion and orbital conditions. Table II contains the tilt program and Table III the sequence of events for SA-8.

A detailed presentation of the predicted operational trajectory parameters is given in Tables IV through VIII. Table IV contains the S-I stage boost flight; Table V the S-IV ullage portion; Table VI the S-IV mainstage and orbital portion of flight to separation. The velocity increment imparted to the S-IV/Pegasus B at separation is 0.3 m/sec. The most sensitive direction for the delta velocity to affect the orbital shapes is along the total velocity direction. Normally the Pegasus velocity will be decreased, with maximum effect being reduction in apogee altitude by approximately 1 km. Table VII contains the S-I retro portion; Table VIII contains the S-I stage ballistic flight to impact. The S-I impact coordinates from the nominal trajectory are 25.7748 deg North geodetic latitude and 71.3160 deg West longitude and 965.97 km downrange.

No dispersion analysis was done from the SA-8 nominal trajectory due to its similarity to SA-9.

TABLE I

SA-8 FACT SHEET

I. Mission

Vehicle	SA-8
Payload	Apollo Boilerplate and Pegasus Satellite

II. Configuration

S-I Stage	8 engines at (188k lbf)	836, 266 newtons per engine (rated)
S-IV Stage	6 engines at (15k lbf)	66, 723 newtons per engine (rated)
Payload	Orbital Configuration 22, 651 lbm Apollo Boilerplate and Pegasus Satellite	

III. Mass Characteristics

Total Mass at Lift-Off	512, 454 kg	(1, 129, 768 lbm)
Mass at First Stage Cutoff (OECO)	117, 375 kg	(258, 767 lbm)
Mainstage Consumption During First Stage of Flight (To Separation)	392, 769 kg	(865, 907 lbm)
Mass at Second Stage Ignition (152. 29 sec)	62, 109 kg	(136, 926 lbm)
Mass at Second Stage Cutoff (628. 58 sec)	15, 343 kg	(33, 826 lbm)
Mainstage Consumption During Second Stage of Flight	45, 297 kg	(99, 863 lbm)
Flight Performance Reserve at S-IV Cutoff	236 kg LOX	(522 lbm)
	48 kg LH_2	(105 lbm)
Instrumentation Unit	1, 212 kg	(2, 673 lbm)
Orbiting Payload (Pegasus Satellite)*	10, 275 kg	(22, 651 lbm)

*After Separation

NOTE: All values are inertial where applicable unless otherwise denoted

TABLE I (CONT)

IV Trajectory and Orbit

A. Launch

Launch Complex and Pad	37B
Latitude	28.53185406 deg
Longitude	80.56495285 deg
Launch Azimuth	90° E of N
Flight Azimuth	105° E of N

B. Trajectory History

First Stage

S-I Stage Roll Tilt Initiation	9 sec
S-I Stage Pitch Tilt Initiation	9 sec
S-I Stage Roll Tilt Termination	24 sec
S-I Stage Roll Angle	15 deg
S-I Stage Mach One	55 sec
S-I Stage Maximum Dynamic Pressure	68 sec
S-I Level Sensors Enabled	138 sec
S-I Stage Pitch Tilt Arrest	138 sec
S-I Stage Pitch Angle at Tilt Arrest	52.45 deg
S-I Stage Inboard Engine Cutoff (IECO)	143.79 sec
S-I Stage Outboard Engine Cutoff (OECO)	149.79 sec
S-I Stage Velocity at OECO (Inertially Ref)	3,028.68 m/sec
(Earth Ref)	2,700.60 m/sec
S-I Stage Path Angle at OECO (Inertially Ref)	56.893 deg
(Earth Ref)	52.226 deg
S-I Stage Altitude at OECO	88.08 km
S-I Stage Range at OECO	79.54 km

TABLE I (CONT)

Separation

Ullage Ignition (S-IV Stage)	150.49 sec
S-I/S-IV Separation	150.59 sec
Retro-Rocket Ignition (S-I Stage)	150.59 sec

Second Stage

S-IV Stage (Main) Ignition	152.29 sec
S-IV Stage 90% Thrust Attained	1.8 sec (Approx.)
S-IV Stage Ullage Rocket Cutoff	154.29 sec
S-IV Stage Ullage Casing and LES Jettison	162.59 sec
S-IV Stage Guidance Initiation	168 sec
S-IV Stage Guidance Cutoff Signal (GCS)	628.582 sec
S-IV Stage Velocity at GCS	7,672.06 m/sec
S-IV Stage Path Angle at GCS	90.005 deg
S-IV Stage Altitude at GCS	509.642 km
S-IV Stage Range at GCS	1,856.39 km
S-IV Stage Latitude at GCS (Geocentric)	22.5547 deg
S-IV Stage Longitude at GCS	63.2171 deg (West)

C. Insertion Conditions

Time	638.582 sec
Velocity	7,675.18 m/sec
Path Angle (Against Local Vertical)	89.9997 deg
Altitude (Oblate Earth)	509.570 km
Range	1,923.53 km
Latitude (Geocentric)	22.304 deg

TABLE I (CONT)

Longitude	62.6233 deg (West)
Azimuth	113.2214 deg
Excess Circular Velocity	66.14 m/sec

D. Orbital Characteristics (Spherical Earth; R_e = 6,378.165 km)

Perigee Altitude	506.5 km
Apogee Altitude	751.2 km
Anomalistic Period	97.29 min
Semi-Major Axis	7,007 km
Eccentricity	.01746
Inclination	31.763 deg
Longitude of Ascending Node*	158.87 deg (East)
Argument of Perigee	133.85 deg
True Anomaly at Insertion	.0183 deg
Eccentric Anomaly at Insertion	.0180 deg
Mean Anomaly at Insertion	.0176 deg
Regression Rate of Node	-6.1 deg/day
Rate of Change of Argument of Perigee	9.4 deg/day
Vis Viva Energy (Twice Total Energy)	-56.99 km^2/sec^2

E. Lifetime Characteristics

Nominal Lifetime	1,200 days
Guaranteed Lifetime	844 days
Ballistic Parameters for Tumbling Vehicle	
C_DA	265 m^2

*Only flight time is reflected due to uncertainty of sidereal time of launch.

TABLE I (CONT)

Post Venting Orbital Mass	10, 275 kg
Ballistic Coefficient (C_D A/M)	.026 m^2/kg

V. Control

Active Sensors	Rate Gyro and Vehicle-Fixed Accelerometers

VI. Guidance

1. First Stage	Time Function Polynomial
2. Second Stage	
(a) In Plane (IGM)	
(b) Crossrange (Delta Min)	

TABLE II

PITCH TILT PROGRAM FOR SATURN I VEHICLE SA-8

Flight Time (sec)	(deg)	Flight Time (sec)	(deg)	Flight Time (sec)	(deg)
0	0	33	6.70	66	24 65
1	0	34	7.15	67	25 25
2	0	35	7.65	68	25.80
3	0	36	8.10	69	26.35
4	0	37	8.60	70	26.95
5	0	38	9.10	71	27.50
6	0	39	9.60	72	28.10
7	0	40	10.10	73	28.65
8	0	41	10.65	74	29.15
9	0	42	11.10	75	29.75
10	0.25	43	11.70	76	30.30
11	0.30	44	12.25	77	30.80
12	0.45	45	12.80	78	31.40
13	0.60	46	13.30	79	31.90
14	0.65	47	13.90	80	32.45
15	0.90	48	14.40	81	33.00
16	1.05	49	14.90	82	33.50
17	1.25	50	15.50	83	34.05
18	1.45	51	16.10	84	34.50
19	1.70	52	16.60	85	35.00
20	1.95	53	17 15	86	35.50
21	2.25	54	17.75	87	36.00
22	2.50	55	18.30	88	36.45
23	2.85	56	18.85	89	36.90
24	3.20	57	19.45	90	37.40
25	3.50	58	20.00	91	37.85
26	3.85	59	20.60	92	38 25
27	4.25	60	21.20	93	38.75
28	4.60	61	21.75	94	39.15
29	5.00	62	22.35	95	39.65
30	5.45	63	22.90	96	40.00
31	5.85	64	23.50	97	40.40
32	6.25	65	24.05	98	40.85

TABLE II (CONT'D)

Flight Time (sec)	(deg)	Flight Time (sec)	(deg)
99	41.20	134	51.75
100	41.65	135	51.75
101	42.00	136	52.15
102	42.35	137	52.40
103	42.80	138	52.45
104	43.15	*168	52.45
105	43.50		
106	43.85		
107	44.25		
108	44.60		
109	44.90		
110	45.25		
111	45.55		
112	45.90		
113	46.25		
114	46.50		
115	46.85		
116	47.15		
117	47.50		
118	47.70		
119	48.05		
120	48.35		
121	48.60		
122	48.85		
123	49.10		
124	49.40		
125	49.65		
126	49.90		
127	50.15		
128	50.40		
129	50.60		
130	50.85		
131	51.10		
132	51.30		
133	51.50		

*Time of IGM

TABLE III

SA-8 SEQUENCE OF EVENTS

Time (From Lift-off)	Event
0	Lift-off
9.0	Initiate Roll and Pitch Tilt
24.0	Terminate Roll
138.0	Signal from Sequencer to Enable Level Sensors
138.0	Tilt Arrest
142.0	S-I Stage Level Sensor Signal
143.79	Inboard Cutoff (S-I Stage)
149.79	Outboard Cutoff (S-I Stage)
150.49	Ullage Rocket Ignition (S-IV Stage)
150.59	Separation, Immediately Followed by Retro Rocket Ignition (S-I Stage)
152.29	S-IV Mainstage Ignition
154.29	Ullage Rocket Thrust Termination
162.59	Jettison Ullage Rocket Casing and LES
168.	Initiate Active Guidance
591.	Signal from Sequencer to Arm LOX Cutoff Capability
628.582	S-IV Stage Guidance Cutoff Signal
638.582	End of Powered Flight
808.582	Close Blowdown Non-Propellant Vents

TABLE III (CONT'D)

809.582	Start S-IV Pegasus/Apollo Separation
869.582	Begin Pegasus Wing Deployment
929.582	Terminate Wing Deployment

TABLE IV-A
S-I STAGE NOMINAL 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	0.00	512454	0	6561766	0.00	44130
5.0	-0.00	0.07	409.3	87.64	3.68	499130	167	6734407	0.05	21345
10.0	-0.00	0.20	410.5	84.94	4.07	485806	763	6767009	0.10	43351
15.0	-0.00	0.44	413.3	81.98	4.50	472388	1890	6807521	0.17	69335
20.0	0.00	0.78	418.6	78.81	4.94	458970	3634	6849373	0.24	98599
25.0	0.02	1.25	427.2	75.49	5.42	445517	6043	6894554	0.31	132581
30.0	0.05	1.86	440.2	72.13	5.94	432063	9114	6949222	0.40	174985
35.0	0.13	2.61	458.2	68.83	6.49	418597	12775	7011122	0.49	232203
40.0	0.25	3.52	481.7	65.72	7.08	405131	16874	7077682	0.60	299830
45.0	0.44	4.59	510.9	62.92	7.64	391668	21168	7146534	0.72	406176
50.0	0.72	5.84	545.6	60.54	8.10	378205	25286	7217692	0.85	575768
55.0	1.12	7.27	584.4	58.67	8.06	364716	28679	7286398	0.99	943544
60.0	1.65	8.88	626.2	57.34	8.66	351228	30835	7349355	1.15	1083360
65.0	2.34	10.66	674.3	56.31	9.82	337698	32118	7410945	1.34	1055521
70.0	3.21	12.62	729.9	55.49	11.32	324168	32191	7467592	1.56	945552
75.0	4.31	14.80	794.2	54.86	13.07	310648	30396	7520701	1.80	792418
80.0	5.67	17.20	868.1	54.39	14.99	297128	26524	7563996	2.06	625607
85.0	7.33	19.86	952.3	54.09	17.04	283678	21359	7598590	2.30	459046
90.0	9.35	22.79	1047.0	53.95	19.12	270229	16704	7621156	2.57	323337
95.0	11.77	26.02	1152.1	53.94	21.21	256776	12665	7634261	2.87	222280
100.0	14.63	29.58	1267.8	54.04	23.37	243323	9241	7639022	3.20	144658
105.0	17.99	33.47	1394.3	54.22	25.62	229891	6434	7638283	3.53	88961
110.0	21.90	37.73	1532.2	54.47	28.01	216458	4306	7637132	3.88	55047
115.0	26.41	42.38	1682.4	54.75	30.59	203043	2790	7629379	4.24	33279
120.0	31.58	47.44	1845.9	55.06	33.43	189628	1771	7620251	4.65	19853
125.0	37.47	52.95	2024.2	55.39	36.64	176255	1129	7610172	5.23	10372
130.0	44.15	58.94	2219.4	55.71	40.28	162881	680	7594647	6.00	3458
135.0	51.69	65.46	2433.9	56.02	44.48	149571	368	7577804	6.94	928
140.0	60.18	72.55	2670.8	56.30	49.37	136260	170	7549507	8.09	97
(1) 143.8	67.31	78.35	2867.5	56.45	53.71	126203	83	7529378	9.11	62
145.0	69.71	80.28	2907.2	56.53	26.10	123761	63	3963859	9.38	58
(2) 149.8	79.54	88.08	3028.7	56.89	25.35	117375	17	3660189	10.02	24
150.0	80.06	88.49	3034.3	56.91	12.19	116884	16	2106452	10.04	23
(3) 150.6	81.23	89.40	3034.0	56.98	-3.48	116601	14	271659	10.04	19

(1) IECO
(2) OECO
(3) Separation

TABLE IV-B
S-I STAGE NOMINAL 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)
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	16.9	-0.0	16.9	0.28	80.5650	28.5319	28.3707
10.0	-0.0	0.2	-0.0	-0.1	36.2	-0.1	36.2	0.30	80.5650	28.5319	28.3707
15.0	-0.0	0.4	-0.0	0.3	57.6	-0.1	57.6	0.34	80.5649	28.5319	28.3707
20.0	0.0	0.8	-0.0	1.7	81.2	-0.1	81.2	1.16	80.5649	28.5319	28.3707
25.0	0.0	1.3	-0.0	4.7	107.0	-0.1	107.1	2.51	80.5648	28.5319	28.3707
30.0	0.1	1.9	-0.0	10.2	135.1	-0.1	135.5	4.29	80.5644	28.5318	28.3706
35.0	0.1	2.6	-0.0	18.8	165.5	-0.0	166.5	6.43	80.5637	28.5316	28.3705
40.0	0.2	3.5	-0.0	31.0	198.1	0.0	200.5	8.84	80.5625	28.5314	28.3702
45.0	0.4	4.6	-0.0	47.2	232.6	0.1	237.3	11.42	80.5606	28.5309	28.3698
50.0	0.7	5.8	-0.0	67.8	268.3	0.2	276.7	14.13	80.5578	28.5303	28.3691
55.0	1.1	7.3	0.0	92.5	303.8	0.4	317.6	16.88	80.5538	28.5294	28.3682
60.0	1.7	8.9	0.0	121.2	337.8	0.5	358.9	19.67	80.5486	28.5282	28.3670
65.0	2.3	10.7	0.0	155.6	373.9	0.7	405.0	22.53	80.5418	28.5266	28.3654
70.0	3.2	12.6	0.0	196.7	413.3	1.0	457.7	25.38	80.5332	28.5246	28.3634
75.0	4.3	14.8	0.0	245.4	456.8	1.3	518.6	28.16	80.5224	28.5220	28.3609
80.0	5.7	17.2	0.0	302.5	505.0	1.6	588.6	30.83	80.5090	28.5188	28.3577
85.0	7.4	19.9	0.0	368.8	557.8	2.0	668.7	33.36	80.4925	28.5149	28.3538
90.0	9.4	22.8	0.0	444.8	615.2	2.5	759.1	35.74	80.4727	28.5101	28.3490
95.0	11.8	26.0	0.1	530.5	676.8	3.0	859.9	37.94	80.4488	28.5044	28.3434
100.0	14.7	29.6	0.1	626.2	742.5	3.6	971.3	39.97	80.4206	28.4977	28.3366
105.0	18.1	33.4	0.1	732.2	812.5	4.4	1093.7	41.82	80.3875	28.4897	28.3287
110.0	22.1	37.7	0.1	848.9	886.9	5.2	1227.7	43.51	80.3489	28.4804	28.3194
115.0	26.6	42.3	0.1	977.1	966.1	6.0	1374.1	45.05	80.3045	28.4697	28.3087
120.0	31.9	47.4	0.2	1117.7	1050.7	7.0	1534.0	46.45	80.2536	28.4573	28.2964
125.0	37.8	52.8	0.2	1272.1	1141.4	8.1	1709.1	47.72	80.1957	28.4432	28.2824
130.0	44.6	58.8	0.3	1441.7	1239.2	9.4	1901.2	48.88	80.1300	28.4272	28.2664
135.0	52.3	65.2	0.3	1628.7	1345.9	10.8	2112.8	49.92	80.0558	28.4090	28.2483
140.0	60.9	72.3	0.4	1835.2	1463.1	12.4	2347.1	50.85	79.9723	28.3885	28.2279
(1) 143.8	68.2	78.0	0.4	2005.7	1562.1	13.8	2542.3	51.44	79.9022	28.3713	28.2107
145.0	70.6	79.9	0.4	2041.8	1579.4	14.2	2581.4	51.61	79.8786	28.3655	28.2049
(2) 149.8	80.7	87.6	0.5	2156.3	1625.9	15.8	2700.6	52.23	79.7821	28.3416	28.1811
150.0	81.2	88.0	0.5	2161.6	1627.9	15.9	2706.1	52.26	79.7769	28.3403	28.1798
(3) 150.6	82.4	88.9	0.5	2163.5	1624.3	16.0	2705.4	52.33	79.7655	28.3374	28.1770

(1) IECO

(2) OECO

(3) Separation

TABLE V-A

S-IV ULLAGE PORTION 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)
150.6	81.23	89.40	3034.0	56.98	-4.81	62186	14	62517	10.04	117
151.0	82.09	90.08	3032.2	57.03	-4.80	62167	12	62517	10.03	103
152.3	84.81	92.20	3026.8	57.19	-4.77	62109	8	62517	9.83	68

TABLE V-B

S-IV ULLAGE PORTION 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)
150.6	82.4	88.9	0.5	2163.5	1624.3	16.0	2705.4	52.33	79.7655	28.3374	28.1770
151.0	83.3	89.5	0.5	2163.7	1620.8	16.1	2703.5	52.38	79.7570	28.3353	28.1749
152.3	86.1	91.6	0.5	2164.3	1609.7	16.4	2697.3	52.56	79.7303	28.3287	28.1682

TABLE VI-A

S-IV STAGE NOMINAL 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)
152.3	84.81	92.20	3026.8	57.19	-4.76	62109	8	63320	9.83	68
153.0	86.31	93.36	3024.1	57.28	-4.42	62080	6	83206	9.73	54
162.6	106.69	108.79	3033.4	58.39	1.10	61216	0	408862	8.43	4
163.0	107.57	109.44	3034.1	58.44	1.27	59763	0	408832	8.38	4
(1) 168.0	118.35	117.32	3043.5	59.00	1.41	59273	0	408464	7.39	1
173.0	129.22	125.10	3053.3	59.53	1.49	58783	0	408118	6.29	0
183.0	151.24	140.40	3073.1	60.45	1.65	57803	0	407690	4.91	0
193.0	173.61	155.38	3095.3	61.35	1.95	56824	0	406958	4.24	0
203.0	196.35	170.05	3120.4	62.25	2.24	55845	0	406473	3.97	0
213.0	219.49	184.40	3148.2	63.14	2.53	54869	0	405844	3.84	0
223.0	243.03	198.45	3178.9	64.03	2.83	53892	0	406131	3.77	0
233.0	267.01	212.20	3212.5	64.91	3.13	52914	0	405393	3.72	0
243.0	291.44	225.66	3248.8	65.78	3.41	51940	0	404173	3.67	0
253.0	316.34	238.81	3287.9	66.65	3.70	50971	0	402800	3.65	0
263.0	341.72	251.68	3329.7	67.50	3.99	50005	0	401393	3.64	0
273.0	367.62	264.25	3374.3	68.35	4.28	49045	0	399979	3.64	0
283.0	394.05	276.54	3421.7	69.18	4.58	48088	0	399181	3.64	0
293.0	421.03	288.53	3472.2	70.00	4.90	47134	0	398618	3.65	0
303.0	448.58	300.23	3525.6	70.81	5.22	46180	0	398204	3.66	0
313.0	476.73	311.65	3582.2	71.61	5.55	45227	0	397936	3.68	0
323.0	505.50	322.79	3641.9	72.39	5.89	44275	0	397888	3.71	0
333.0	534.91	333.64	3705.0	73.16	6.23	43323	0	397799	3.75	0
343.0	565.00	344.20	3771.4	73.91	6.58	42371	0	397660	3.79	0
353.0	595.78	354.49	3841.2	74.65	6.93	41419	0	397310	3.83	0
363.0	627.29	364.48	3914.4	75.38	7.29	40468	0	397027	3.88	0
373.0	659.55	374.19	3991.0	76.09	7.65	39520	0	396389	3.93	0
383.0	692.59	383.61	4071.2	76.79	8.02	38572	0	395900	3.98	0
393.0	726.44	392.74	4155.0	77.47	8.40	37626	0	395628	4.04	0
403.0	761.12	401.58	4242.6	78.14	8.80	36680	0	395632	4.11	0
413.0	796.68	410.11	4334.2	78.80	9.21	35734	0	395733	4.18	0
423.0	833.13	418.35	4429.8	79.44	9.63	34787	0	395877	4.26	0
433.0	870.53	426.28	4529.6	80.06	10.07	33840	0	395952	4.35	0
443.0	908.90	433.91	4633.7	80.68	10.51	32893	0	395679	4.44	0
453.0	948.28	441.22	4742.2	81.28	10.96	31947	0	395300	4.53	0
463.0	988.70	448.21	4855.1	81.87	11.43	31002	0	395006	4.63	0
473.0	1030.22	454.88	4972.8	82.44	11.92	30057	0	394828	4.73	0
483.0	1072.86	461.21	5095.5	83.00	12.43	29114	0	394843	4.84	0
493.0	1116.68	467.21	5223.4	83.55	12.98	28170	0	395077	4.96	0
503.0	1161.72	472.85	5356.8	84.09	13.56	27225	0	395270	5.08	0
513.0	1208.02	478.15	5496.0	84.62	14.16	26280	0	395529	5.21	0

TABLE VI-A (CONT)

S-IV STAGE NOMINAL 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)
	523.0	1255.66	483.08	5641.4	85.13	14.79	25334	0	395520	5.34	0
	533.0	1304.67	487.63	5793.1	85.63	15.45	24388	0	395259	5.48	0
	543.0	1355.12	491.80	5951.5	86.12	16.15	23443	0	395233	5.63	0
	553.0	1407.07	495.58	6117.3	86.60	16.92	22498	0	395532	5.79	0
	563.0	1460.59	498.94	6290.9	87.07	17.74	21551	0	395778	5.95	0
	573.0	1515.75	501.89	6472.9	87.54	18.62	20604	0	395898	6.13	0
	583.0	1572.64	504.40	6664.0	87.99	19.56	19657	0	396003	6.32	0
	593.0	1631.34	506.45	6864.7	88.44	20.57	18709	0	395790	6.52	0
	603.0	1691.95	508.01	7076.0	88.88	21.67	17762	0	395580	6.72	0
	613.0	1754.56	509.07	7298.7	89.33	22.87	16817	0	395241	6.95	0
	623.0	1819.29	509.59	7534.1	89.76	24.26	15871	0	395227	7.18	0
(2)	628.6	1856.39	509.64	7672.1	90.00	25.21	15343	0	396538	7.32	0
	633.1	1886.60	509.61	7675.2	90.01	0.01	15313	0	0	7.33	0
(3)	638.6	1923.53	509.57	7675.2	90.00	0.01	15313	C	0	7.33	0
	683.6	2221.75	509.42	7675.2	89.95	0	15300	0	0	7.33	0
	733.6	2257.46	509.57	7674.8	89.90	-.01	15285	0	0	7.33	0
	783.6	2893.12	510.09	7674.0	89.85	-.01	15271	0	0	7.33	0
(4)	809.6	3067.64	510.49	7673.5	89.82	-.02	15263	0	0	7.33	0

(1) Initiate Active Guidance
(2) GCS
(3) Insertion
(4) S-IV Pegasus/Apollo Separation

TABLE VI-B

S-IV STAGE NOMINAL 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)
	152.3	86.1	91.6	0.5	2164.3	1609.7	16.4	2697.3	52.56	79.7303	28.3287	28.1682
	153.0	87.6	92.8	0.6	2164.7	1603.7	16.5	2694.1	52.65	79.7156	28.3250	28.1646
	162.6	108.6	107.9	0.7	2207.2	1551.4	18.4	2698.0	53.90	79.5156	28.2749	28.1147
	163.0	109.5	108.5	0.7	2209.3	1549.4	18.5	2698.5	53.95	79.5070	28.2728	28.1126
(1)	168.0	120.6	116.2	0.8	2234.4	1524.8	19.4	2705.2	54.58	79.4014	28.2461	28.0860
	173.0	131.8	123.8	0.9	2259.2	1501.0	21.7	2712.5	55.20	79.2949	28.2191	28.0591
	183.0	154.7	138.6	1.2	2304.4	1459.6	27.2	2727.9	56.25	79.0795	28.1638	28.0040
	193.0	177.9	153.0	1.5	2350.7	1419.0	31.9	2746.0	57.28	78.8611	28.1068	27.9472
	203.0	201.7	166.9	1.8	2399.2	1377.9	36.0	2767.0	58.32	78.6393	28.0482	27.8888
	213.0	225.9	180.5	2.2	2449.5	1336.8	39.6	2790.8	59.36	78.4141	27.9880	27.8288
	223.0	250.7	193.7	2.6	2501.8	1295.6	42.9	2817.6	60.40	78.1852	27.9260	27.7671
	233.0	276.0	206.4	3.0	2555.9	1254.2	45.9	2847.4	61.42	77.9524	27.8624	27.7037
	243.0	301.8	218.8	3.5	2612.0	1212.4	48.8	2880.1	62.44	77.7157	27.7969	27.6385
	253.0	328.2	230.7	4.0	2670.1	1170.1	51.5	2915.7	63.45	77.4747	27.7297	27.5715
	263.0	355.2	242.2	4.5	2730.0	1127.3	54.3	2954.1	64.45	77.2293	27.6605	27.5026
	273.0	382.8	253.2	5.1	2791.9	1083.7	57.0	2995.4	65.44	76.9794	27.5893	27.4317
	283.0	411.1	263.8	5.7	2855.9	1039.4	59.8	3039.7	66.42	76.7247	27.5161	27.3588
	293.0	439.9	274.0	6.3	2922.0	994.3	62.7	3087.1	67.38	76.4651	27.4408	27.2837
	303.0	469.5	283.7	6.9	2990.3	948.4	65.7	3137.7	68.33	76.2004	27.3632	27.2064
	313.0	499.8	293.0	7.6	3060.8	901.5	68.8	3191.6	69.26	75.9304	27.2833	27.1268
	323.0	530.7	301.7	8.3	3133.8	853.6	72.0	3248.8	70.18	75.6549	27.2009	27.0448
	333.0	562.4	310.0	9.1	3209.2	804.6	75.3	3309.4	71.07	75.3737	27.1160	26.9602
	343.0	594.9	317.8	9.8	3287.1	754.4	78.8	3373.5	71.95	75.0866	27.0285	26.8730
	353.0	628.2	325.1	10.6	3367.5	702.7	82.4	3441.0	72.82	74.7933	26.9382	26.7831
	363.0	662.3	331.9	11.5	3450.5	649.5	86.0	3512.2	73.66	74.4937	26.8449	26.6902
	373.0	697.2	338.1	12.4	3536.1	594.5	89.8	3586.9	74.48	74.1875	26.7487	26.5943
	383.0	733.0	343.8	13.3	3624.3	537.7	93.8	3665.2	75.29	73.8745	26.6493	26.4953
	393.0	769.7	348.8	14.2	3715.3	478.9	97.8	3747.3	76.08	73.5545	26.5466	26.3931
	403.0	807.3	353.3	15.2	3809.1	417.9	101.9	3833.3	76.85	73.2271	26.4405	26.2874
	413.0	845.9	357.2	16.3	3905.8	354.7	106.2	3923.3	77.61	72.8923	26.3308	26.1781
	423.0	885.4	360.4	17.4	4005.6	289.0	110.5	4017.5	78.34	72.5496	26.2174	26.0652
	433.0	926.0	363.0	18.5	4108.5	220.7	115.0	4116.0	79.05	72.1989	26.1000	25.9483
	443.0	967.6	364.8	19.7	4214.5	149.6	119.5	4218.9	79.75	71.8399	25.9787	25.8274
	453.0	1010.3	365.9	20.9	4323.7	75.3	124.2	4326.2	80.43	71.4722	25.8530	25.7023
	463.0	1054.1	366.3	22.1	4436.2	-2.3	129.0	4438.1	81.10	71.0956	25.7229	25.5728
	473.0	1099.1	365.9	23.5	4552.0	-83.5	133.9	4554.8	81.74	70.7097	25.5882	25.4386
	483.0	1145.2	364.6	24.8	4671.4	-168.5	139.0	4676.5	82.37	70.3144	25.4486	25.2996
	493.0	1192.5	362.5	26.2	4794.5	-257.5	144.1	4803.6	82.99	69.9091	25.3040	25.1556
	503.0	1241.1	359.5	27.7	4921.5	-350.7	149.4	4936.3	83.59	69.4937	25.1540	25.0963
	513.0	1290.9	355.5	29.2	5052.6	-448.7	154.7	5074.8	84.17	69.0676	24.9985	24.8515

TABLE VI-B (CONT)

S-IV STAGE NOMINAL 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)
	523.0	1342.1	350.5	30.8	5187.8	-551.8	160.2	5219.6	84.74	68.6305	24.8372	24.6908
	533.0	1394.7	344.4	32.4	5327.4	-660.2	165.9	5370.7	85.29	68.1820	24.6698	24.5241
	543.0	1448.7	337.3	34.1	5471.5	-774.5	171.6	5528.7	85.83	67.7216	24.4959	24.3511
	553.0	1504.2	328.9	35.9	5620.4	-895.1	177.5	5694.0	86.35	67.2489	24.3153	24.1713
	563.0	1561.1	319.3	37.7	5774.5	-1022.6	183.5	5867.2	86.86	66.7633	24.1277	23.9845
	573.0	1619.7	308.4	39.5	5934.1	-1157.7	189.6	6049.0	87.36	66.2644	23.9326	23.7902
	583.0	1679.8	296.2	41.5	6099.5	-1301.1	195.9	6239.8	87.85	65.7514	23.7296	23.5881
	593.0	1741.7	282.4	43.4	6270.9	-1453.8	202.3	6440.4	88.34	65.2239	23.5182	23.3778
	603.0	1805.3	267.0	45.5	6448.7	-1616.7	208.8	6651.5	88.81	64.6810	23.2981	23.1587
	613.0	1870.7	250.0	47.6	6633.2	-1791.1	215.5	6874.1	89.29	64.1221	23.0687	22.9303
	623.0	1937.9	231.2	49.8	6825.3	-1977.6	222.3	7109.5	89.75	63.5462	22.8294	22.6922
(2)	628.6	1976.4	219.8	51.1	6936.7	-2087.3	226.1	7247.5	90.01	63.2171	22.6913	22.5547
	633.1	2007.6	210.4	52.1	6929.7	-2121.1	227.7	7250.6	90.01	62.9496	22.5783	22.4422
(3)	638.6	2045.6	198.6	53.3	6917.5	-2160.5	229.6	7250.6	90.00	62.6233	22.4395	22.3041
	683.6	2350.6	95.6	63.9	6810.6	-2476.0	244.2	7250.9	89.95	60.0130	21.2915	21.1616
	733.6	2687.7	-37.0	76.5	6672.8	-2824.8	258.9	7250.7	89.90	57.1272	19.9447	19.8216
	783.6	3017.6	-186.8	89.7	6516.9	-3165.8	271.6	7250.2	89.84	54.2947	18.5451	18.4293
(4)	809.6	3185.9	-271.3	96.9	6428.7	-3339.8	277.5	7249.8	89.81	52.8419	17.7980	17.6863

(1) Initiate Active Guidance
(2) GCS
(3) Insertion
(4) S-IV Pegasus/Apollo Separation

TABLE VII-A

S-I RETRO PORTION 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) 150.6	81.23	89.40	3034.0	56.98	-10.91	54515	14	275724	10.04	2135
151.0	82.09	90.07	3029.5	57.04	-12.36	54356	12	354417	10.02	1877
151.6	83.33	91.04	3021.9	57.12	-14.48	54124	10	468726	9.91	1539
152.6	85.44	92.68	3006.6	57.27	-16.70	53781	7	587092	9.72	1108
(2) 153.0	86.38	93.40	3001.0	57.34	-5.78	53704	6	3	9.64	960

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

TABLE VII-B

S-I RETRO PORTION TRAJECTORY

EARTH FIXED PARAMETERS

	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)
(1)	150.6	82.4	88.9	0.5	2163.5	1624.3	16.0	2705.4	52.33	79.7655	28.3374	28.1770
	151.0	83.3	89.5	0.5	2161.5	1619.1	16.1	2700.7	52.38	79.7570	28.3353	28.1749
	151.6	84.6	90.5	0.5	2157.7	1610.9	16.2	2692.8	52.47	79.7448	28.3323	28.1718
	152.6	86.7	92.1	0.6	2149.3	1595.3	16.3	2676.7	52.61	79.7242	28.3272	28.1667
(2)	153.0	87.7	92.8	0.6	2146.6	1589.1	16.4	2670.9	52.67	79.7149	28.3248	28.1644

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

TABLE VIII-A

S-I COAST TO IMPACT 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)
153.0	86.38	93.40	3001.0	57.34	-5.78	53704	6	0	9.64	961
156.0	92.57	98.16	2985.8	57.73	-5.71	53704	3	0	9.24	399
162.0	105.08	107.56	2955.7	58.53	-5.57	53704	1	0	8.29	78
168.0	117.55	116.66	2926.3	59.34	-5.44	53704	0	0	7.13	19
174.0	129.99	125.45	2897.8	60.17	-5.31	53704	0	0	5.88	6
180.0	142.38	133.93	2870.0	61.02	-5.17	53704	0	0	4.98	3
186.0	154.73	142.11	2843.1	61.88	-5.03	53704	0	0	4.39	1
192.0	167.05	149.99	2816.9	62.76	-4.89	53704	0	0	3.96	1
198.0	179.34	157.57	2791.6	63.65	-4.74	53704	0	0	3.70	1
204.0	191.59	164.84	2767.2	64.56	-4.59	53704	0	0	3.53	0
210.0	203.81	171.81	2743.6	65.48	-4.44	53704	0	0	3.39	0
216.0	216.00	178.48	2720.9	66.42	-4.28	53704	0	0	3.29	0
222.0	228.16	184.85	2699.0	67.37	-4.12	53704	0	0	3.20	0
228.0	240.29	190.92	2678.1	68.34	-3.95	53704	0	0	3.12	0
234.0	252.40	196.69	2658.1	69.32	-3.78	53704	0	0	3.06	0
240.0	264.49	202.17	2639.0	70.32	-3.61	53704	0	0	3.00	0
246.0	276.55	207.34	2620.8	71.32	-3.44	53704	0	0	2.94	0
252.0	288.58	212.22	2603.6	72.35	-3.26	53704	0	0	2.89	0
258.0	300.60	216.80	2587.4	73.38	-3.08	53704	0	0	2.85	0
264.0	312.60	221.08	2572.1	74.43	-2.89	53704	0	0	2.80	0
270.0	324.58	225.06	2557.9	75.48	-2.70	53704	0	0	2.76	0
276.0	336.55	228.75	2544.6	76.55	-2.51	53704	0	0	2.73	0
282.0	348.50	232.15	2532.4	77.63	-2.31	53704	0	0	2.69	0
288.0	360.43	235.24	2521.2	78.72	-2.11	53704	0	0	2.67	0
294.0	372.36	238.05	2511.0	79.81	-1.91	53704	0	0	2.64	0
300.0	384.27	240.55	2501.8	80.92	-1.70	53704	0	0	2.62	0
306.0	396.17	242.76	2493.7	82.03	-1.50	53704	0	0	2.60	0
312.0	408.06	244.68	2486.7	83.15	-1.29	53704	0	0	2.59	0
318.0	419.95	246.30	2480.8	84.27	-1.08	53704	0	0	2.57	0
324.0	431.83	247.63	2475.9	85.40	-0.86	53704	0	0	2.56	0
330.0	443.70	248.67	2472.0	86.54	-0.65	53704	0	0	2.55	0
336.0	455.58	249.40	2469.3	87.67	-0.43	53704	0	0	2.54	0
342.0	467.45	249.85	2467.6	88.81	-0.22	53704	0	0	2.54	0
348.0	479.31	250.00	2467.1	89.95	-0.00	53704	0	0	2.54	0
348.3	479.87	250.00	2467.1	90.00	0.01	53704	0	0	2.54	0
354.0	491.18	249.86	2467.6	91.09	0.21	53704	0	0	2.54	0
360.0	503.05	249.42	2469.2	92.22	0.43	53704	0	0	2.54	0
366.0	514.92	248.69	2471.8	93.36	0.64	53704	0	0	2.55	0
372.0	526.80	247.66	2475.6	94.49	0.86	53704	0	0	2.56	0
378.0	538.68	246.34	2480.4	95.62	1.07	53704	0	0	2.57	0

TABLE VIII-A (CONT)

S-I COAST TO IMPACT 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)
384.0	550.57	244.72	2486.3	96.75	1.28	53704	0	0	2.58	0
390.0	562.47	242.81	2493.3	97.86	1.49	53704	0	0	2.60	0
396.0	574.37	240.61	2501.3	98.98	1.70	53704	0	0	2.62	0
402.0	586.29	238.11	2510.4	100.08	1.90	53704	0	0	2.64	0
408.0	598.22	235.31	2520.5	101.18	2.11	53704	0	0	2.67	0
414.0	610.16	232.22	2531.7	102.27	2.31	53704	0	0	2.69	0
420.0	622.11	228.84	2543.8	103.35	2.50	53704	0	0	2.73	0
426.0	634.08	225.15	2557.0	104.42	2.70	53704	0	0	2.76	0
432.0	646.07	221.18	2571.2	105.47	2.89	53704	0	0	2.80	0
438.0	658.07	216.90	2586.4	106.52	3.07	53704	0	0	2.84	0
444.0	670.10	212.33	2602.6	107.55	3.25	53704	0	0	2.89	0
450.0	682.14	207.46	2619.7	108.58	3.43	53704	0	0	2.94	0
456.0	694.21	202.29	2637.8	109.59	3.61	53704	0	0	3.00	0
462.0	706.30	196.83	2656.9	110.58	3.78	53704	0	0	3.06	0
468.0	718.42	191.06	2676.8	111.56	3.95	53704	0	0	3.12	0
474.0	730.56	185.00	2697.7	112.53	4.11	53704	0	0	3.20	0
480.0	742.73	178.64	2719.5	113.48	4.27	53704	0	0	3.29	0
486.0	754.93	171.97	2742.2	114.42	4.43	53704	0	0	3.39	0
492.0	767.16	165.01	2765.7	115.35	4.58	53704	0	0	3.52	0
498.0	779.42	157.74	2790.1	116.25	4.74	53704	0	0	3.70	1
504.0	791.72	150.17	2815.4	117.15	4.88	53704	0	0	3.96	1
510.0	804.05	142.30	2841.5	118.03	5.03	53704	0	0	4.38	1
516.0	816.42	134.13	2868.4	118.89	5.17	53704	0	0	4.96	2
522.0	828.82	125.65	2896.1	119.74	5.30	53704	0	0	5.85	6
528.0	841.27	116.87	2924.6	120.57	5.44	53704	0	0	7.11	19
534.0	853.75	107.78	2953.9	121.39	5.57	53704	0	0	8.27	76
539.0	864.15	100.00	2978.8	122.05	5.67	53704	2	0	9.10	288
540.0	866.28	98.38	2983.9	122.19	5.69	53704	2	0	9.23	383
546.0	878.85	88.68	3014.6	122.97	5.78	53704	15	0	9.97	2405
552.0	891.47	78.67	3045.5	123.74	5.68	53704	90	0	9.78	14191
558.0	904.12	68.36	3073.9	124.50	4.82	53704	424	0	9.23	66671
564.0	916.79	57.77	3091.0	125.22	1.35	53704	1672	0	8.69	259575
570.0	929.35	47.00	3066.6	125.87	-10.98	53704	6046	0	8.36	927979
576.0	941.42	36.39	2882.5	126.26	-59.13	53704	23024	0	8.18	3520068
582.0	951.66	27.13	2262.7	125.62	-142.04	53704	54825	0	6.49	7980175
588.0	958.29	20.90	1423.1	122.79	-121.08	53704	48843	0	3.79	6865668
594.0	961.70	17.46	899.1	117.66	-60.62	53704	23884	0	2.00	3637890
600.0	963.38	15.52	655.8	112.47	-27.20	53704	10197	0	1.11	1873455
606.0	964.26	14.25	558.5	109.77	-7.59	53704	5911	0	0.76	857889
612.0	964.81	13.15	522.6	109.82	-2.93	53704	5323	0	0.66	638129

TABLE VIII-A (CONT)

S-I COAST TO IMPACT 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)
	618.0	965.19	12.11	499.4	110.02	-1.87	53704	5256	0	0.60	600298
	624.0	965.45	11.10	482.5	109.98	-1.57	53704	5294	0	0.56	595526
	630.0	965.63	10.13	469.7	109.67	-1.39	53704	5321	0	0.52	591897
	636.0	965.75	9.21	460.1	109.18	-1.25	53704	5337	0	0.49	587656
	642.0	965.83	8.32	452.9	108.60	-1.13	53704	5340	0	0.46	582726
	648.0	965.88	7.47	447.6	107.99	-1.02	53704	5337	0	0.43	577741
	654.0	965.91	6.66	443.7	107.38	-0.93	53704	5332	0	0.41	573102
	660.0	965.93	5.88	440.7	106.78	-0.86	53704	5326	0	0.39	569616
	666.0	965.95	5.13	438.4	106.19	-0.80	53704	5313	0	0.37	566548
	672.0	965.95	4.41	436.5	105.63	-0.74	53704	5297	0	0.36	563369
	678.0	965.96	3.72	435.0	105.10	-0.69	53704	5282	0	0.34	560355
	684.0	965.96	3.05	433.7	104.61	-0.63	53704	5267	0	0.33	557550
	690.0	965.97	2.41	432.7	104.14	-0.58	53704	5253	0	0.31	554933
	696.0	965.97	1.78	431.7	103.71	-0.54	53704	5239	0	0.30	552454
	702.0	965.97	1.18	430.9	103.31	-0.50	53704	5226	0	0.29	550077
	708.0	965.97	0.59	430.2	102.95	-0.45	53704	5212	0	0.28	547767
	714.0	965.97	0.02	429.6	102.61	-0.41	53704	5199	0	0.27	545511
(1)	714.2	965.97	-0.00	429.6	102.60	-0.41	53704	5198	0	0.27	545427

(1) Theoretical Ballistic Impact

TABLE VIII-B

S-I COAST TO IMPACT 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)
153.0	87.7	92.8	0.6	2146.6	1589.1	16.4	2670.9	52.67	79.7149	28.3248	28.1644
156.0	94.1	97.5	0.6	2145.6	1561.7	17.0	2653.9	53.08	79.6542	28.3097	28.1493
162.0	106.9	106.7	0.7	2143.6	1506.4	18.2	2620.0	53.91	79.5315	28.2789	28.1187
168.0	119.8	115.6	0.8	2141.5	1451.3	19.4	2587.0	54.78	79.4092	28.2480	28.0879
174.0	132.6	124.1	0.9	2139.3	1396.3	20.6	2554.7	55.66	79.2875	28.2171	28.0571
180.0	145.5	132.3	1.1	2137.1	1341.5	21.7	2523.3	56.56	79.1662	28.1861	28.0262
186.0	158.3	140.2	1.2	2134.8	1286.8	22.9	2492.7	57.49	79.0454	28.1550	27.9952
192.0	171.1	147.8	1.3	2132.4	1232.3	24.0	2463.0	58.43	78.9250	28.1238	27.9642
198.0	183.9	155.0	1.5	2130.0	1177.9	25.1	2434.1	59.40	78.8051	28.0926	27.9330
204.0	196.6	161.9	1.6	2127.5	1123.6	26.2	2406.1	60.40	78.6855	28.0612	27.9018
210.0	209.4	168.5	1.8	2124.9	1069.5	27.3	2379.1	61.41	78.5664	28.0298	27.8705
216.0	222.1	174.7	2.0	2122.3	1015.4	28.4	2352.9	62.45	78.4476	27.9983	27.8391
222.0	234.9	180.6	2.2	2119.7	961.5	29.5	2327.7	63.51	78.3293	27.9667	27.8076
228.0	247.6	186.3	2.3	2116.9	907.7	30.5	2303.5	64.59	78.2112	27.9350	27.7760
234.0	260.3	191.5	2.5	2114.1	854.0	31.6	2280.3	65.69	78.0936	27.9032	27.7443
240.0	272.9	196.5	2.7	2111.3	800.4	32.6	2258.1	66.82	77.9762	27.8713	27.7126
246.0	285.6	201.1	2.9	2108.3	746.8	33.6	2237.0	67.97	77.8592	27.8393	27.6807
252.0	298.2	205.5	3.1	2105.3	693.4	34.6	2216.9	69.13	77.7424	27.8072	27.6487
258.0	310.9	209.5	3.3	2102.3	640.1	35.6	2197.9	70.32	77.6260	27.7750	27.6167
264.0	323.5	213.1	3.5	2099.2	586.8	36.6	2180.0	71.53	77.5098	27.7427	27.5845
270.0	336.0	216.5	3.8	2096.0	533.6	37.6	2163.2	72.76	77.3939	27.7103	27.5522
276.0	348.6	219.6	4.0	2092.8	480.4	38.5	2147.6	74.00	77.2782	27.6778	27.5198
282.0	361.2	222.3	4.2	2089.5	427.4	39.4	2133.1	75.27	77.1628	27.6452	27.4873
288.0	373.7	224.7	4.5	2086.2	374.3	40.4	2119.9	76.54	77.0475	27.6124	27.4547
294.0	386.2	226.8	4.7	2082.8	321.4	41.3	2107.8	77.84	76.9325	27.5796	27.4220
300.0	398.7	228.5	5.0	2079.3	268.5	42.2	2097.0	79.15	76.8177	27.5466	27.3892
306.0	411.1	230.0	5.2	2075.8	215.6	43.0	2087.4	80.47	76.7031	27.5135	27.3562
312.0	423.6	231.1	5.5	2072.2	162.7	43.9	2079.0	81.80	76.5886	27.4803	27.3231
318.0	436.0	231.9	5.7	2068.5	109.9	44.8	2071.9	83.14	76.4743	27.4470	27.2899
324.0	448.4	232.4	6.0	2064.8	57.1	45.6	2066.1	84.49	76.3602	27.4135	27.2566
330.0	460.8	232.6	6.3	2061.0	4.4	46.4	2061.6	85.84	76.2461	27.3799	27.2231
336.0	473.1	232.5	6.6	2057.2	-48.3	47.2	2058.3	87.21	76.1322	27.3462	27.1895
342.0	485.5	232.0	6.9	2053.3	-101.1	48.0	2056.4	88.57	76.0185	27.3124	27.1558
348.0	497.8	231.3	7.1	2049.4	-153.8	48.8	2055.7	89.94	75.9048	27.2784	27.1219
348.3	498.4	231.2	7.2	2049.2	-156.3	48.8	2055.7	90.00	75.8994	27.2768	27.1203
354.0	510.1	230.2	7.4	2045.3	-206.5	49.6	2056.3	91.30	75.7912	27.2442	27.0879
360.0	522.3	228.8	7.7	2041.3	-259.2	50.3	2058.3	92.67	75.6776	27.2100	27.0538
366.0	534.6	227.1	8.0	2037.1	-311.9	51.0	2061.5	94.03	75.5641	27.1755	27.0195
372.0	546.8	225.1	8.4	2032.9	-364.6	51.8	2066.0	95.38	75.4507	27.1410	26.9851
378.0	559.0	222.7	8.7	2028.6	-417.4	52.5	2071.8	96.73	75.3373	27.1062	26.9505

TABLE VIII-B (CONT)

S-I COAST TO IMPACT TRAJECTORY

EARTH FIXED PARAMETERS

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)
384.0	571.1	220.1	9.0	2024.3	-470.1	53.2	2078.9	98.08	75.2240	27.0714	26.9157
390.0	583.3	217.1	9.3	2019.9	-522.9	53.8	2087.2	99.41	75.1106	27.0363	26.8808
396.0	595.4	213.8	9.6	2015.5	-575.7	54.5	2096.8	100.73	74.9972	27.0011	26.8458
402.0	607.4	210.2	10.0	2010.9	-628.5	55.1	2107.6	102.04	74.8839	26.9657	26.8105
408.0	619.5	206.2	10.3	2006.3	-681.4	55.8	2119.6	103.33	74.7705	26.9302	26.7752
414.0	631.5	202.0	10.6	2001.7	-734.3	56.4	2132.9	104.61	74.6571	26.8945	26.7396
420.0	643.5	197.4	11.0	1996.9	-787.3	57.0	2147.3	105.87	74.5436	26.8586	26.7039
426.0	655.5	192.5	11.3	1992.1	-840.3	57.5	2162.9	107.12	74.4300	26.8226	26.6680
432.0	667.4	187.3	11.7	1987.3	-893.4	58.1	2179.6	108.34	74.3164	26.7864	26.6319
438.0	679.3	181.8	12.0	1982.3	-946.5	58.7	2197.5	109.55	74.2027	26.7499	26.5956
444.0	691.2	176.0	12.4	1977.3	-999.8	59.2	2216.5	110.74	74.0889	26.7133	26.5591
450.0	703.0	169.8	12.7	1972.2	-1053.0	59.7	2236.5	111.91	73.9750	26.6765	26.5225
456.0	714.9	163.3	13.1	1967.1	-1106.4	60.2	2257.7	113.06	73.8610	26.6396	26.4856
462.0	726.7	156.5	13.4	1961.8	-1159.8	60.7	2279.8	114.18	73.7469	26.6024	26.4486
468.0	738.4	149.4	13.8	1956.5	-1213.3	61.1	2303.0	115.29	73.6325	26.5650	26.4114
474.0	750.1	142.0	14.2	1951.2	-1267.0	61.6	2327.2	116.37	73.5181	26.5274	26.3739
480.0	761.8	134.2	14.5	1945.7	-1320.7	62.0	2352.4	117.43	73.4034	26.4896	26.3363
486.0	773.5	126.1	14.9	1940.2	-1374.5	62.4	2378.5	118.47	73.2886	26.4515	26.2984
492.0	785.1	117.7	15.3	1934.5	-1428.4	62.8	2405.6	119.48	73.1736	26.4133	26.2603
498.0	796.7	109.0	15.7	1928.8	-1482.4	63.2	2433.5	120.48	73.0583	26.3748	26.2220
504.0	808.3	99.9	16.1	1923.1	-1536.6	63.6	2462.4	121.45	72.9429	26.3361	26.1834
510.0	819.8	90.6	16.4	1917.2	-1590.8	63.9	2492.1	122.40	72.8272	26.2972	26.1447
516.0	831.3	80.8	16.8	1911.3	-1645.2	64.3	2522.7	123.32	72.7112	26.2580	26.1057
522.0	842.7	70.8	17.2	1905.2	-1699.8	64.6	2554.1	124.23	72.5950	26.2186	26.0664
528.0	854.1	60.5	17.6	1899.1	-1754.5	64.9	2586.3	125.11	72.4785	26.1789	26.0269
534.0	865.5	49.8	18.0	1892.9	-1809.3	65.1	2619.3	125.97	72.3617	26.1390	25.9872
539.0	874.9	40.6	18.3	1887.6	-1854.9	65.4	2647.3	126.67	72.2645	26.1057	25.9540
540.0	876.8	38.7	18.4	1886.6	-1864.2	65.4	2653.1	126.81	72.2446	26.0989	25.9472
546.0	888.1	27.4	18.8	1880.1	-1919.3	65.6	2687.5	127.63	72.1272	26.0584	25.9069
552.0	899.4	15.7	19.2	1873.1	-1974.0	65.8	2722.0	128.43	72.0094	26.0177	25.8664
558.0	910.6	3.7	19.6	1863.8	-2026.7	65.9	2754.2	129.20	71.8914	25.9768	25.8256
564.0	921.7	-8.6	20.0	1846.4	-2070.4	65.7	2774.9	129.97	71.7734	25.9357	25.7847
570.0	932.7	-21.1	20.3	1801.2	-2082.3	64.5	2754.0	130.72	71.6564	25.8948	25.7440
576.0	943.2	-33.3	20.7	1652.2	-1971.1	59.5	2572.7	131.50	71.5441	25.8555	25.7048
582.0	952.0	-44.0	21.0	1226.7	-1518.6	44.5	1952.7	132.45	71.4489	25.8220	25.6714
588.0	957.6	-51.2	21.2	670.9	-879.9	24.5	1106.8	133.99	71.3873	25.8002	25.6498
594.0	960.5	-55.1	21.4	322.4	-471.5	11.9	571.3	136.93	71.3556	25.7890	25.6386
600.0	961.8	-57.3	21.4	154.9	-277.3	5.8	317.7	142.09	71.3400	25.7835	25.6331
606.0	962.5	-58.7	21.4	81.8	-203.6	3.2	219.5	149.39	71.3319	25.7806	25.6303
612.0	962.9	-59.8	21.4	48.4	-186.7	2.0	192.9	156.73	71.3268	25.7788	25.6284

TABLE VIII-B (CONT)

S-I COAST TO IMPACT TRAJECTORY

EARTH FIXED PARAMETERS

	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)
	618.0	963.1	-60.9	21.5	26.1	-177.0	1.2	178.9	162.87	71.3232	25.7775	25.6272
	624.0	963.2	-61.9	21.5	10.6	-168.4	0.6	168.7	167.67	71.3208	25.7767	25.6263
	630.0	963.2	-62.9	21.5	-0.1	-159.9	0.2	159.9	171.30	71.3191	25.7761	25.6257
	636.0	963.2	-63.9	21.5	-7.1	-151.8	-0.1	152.0	173.97	71.3180	25.7757	25.6253
	642.0	963.2	-64.7	21.5	-11.6	-144.4	-0.2	144.9	175.88	71.3173	25.7754	25.6250
	648.0	963.1	-65.6	21.5	-14.3	-137.7	-0.3	138.4	177.22	71.3169	25.7752	25.6249
	654.0	963.0	-66.4	21.5	-15.9	-131.6	-0.4	132.6	178.14	71.3166	25.7751	25.6247
	660.0	962.9	-67.2	21.5	-16.6	-126.1	-0.4	127.2	178.76	71.3164	25.7750	25.6247
	666.0	962.8	-67.9	21.4	-16.8	-121.1	-0.5	122.2	179.17	71.3163	25.7750	25.6246
	672.0	962.7	-68.6	21.4	-16.7	-116.4	-0.5	117.6	179.43	71.3162	25.7749	25.6246
	678.0	962.6	-69.3	21.4	-16.4	-112.1	-0.4	113.3	179.59	71.3161	25.7749	25.6245
	684.0	962.5	-70.0	21.4	-16.1	-108.2	-0.4	109.4	179.69	71.3161	25.7749	25.6245
	690.0	962.4	-70.6	21.4	-15.6	-104.6	-0.4	105.7	179.75	71.3161	25.7749	25.6245
	696.0	962.3	-71.2	21.4	-15.2	-101.2	-0.4	102.3	179.79	71.3161	25.7748	25.6245
	702.0	962.2	-71.8	21.4	-14.8	-98.1	-0.4	99.2	179.81	71.3160	25.7748	25.6245
	708.0	962.1	-72.4	21.4	-14.4	-95.3	-0.4	96.4	179.82	71.3160	25.7748	25.6244
	714.0	962.0	-73.0	21.4	-14.0	-92.8	-0.4	93.8	179.83	71.3160	25.7748	25.6244
(1)	714.2	962.0	-73.0	21.4	-14.0	-92.7	-0.4	93.7	179.83	71.3160	25.7748	25.6244

(1) Theoretical Ballistic Impact

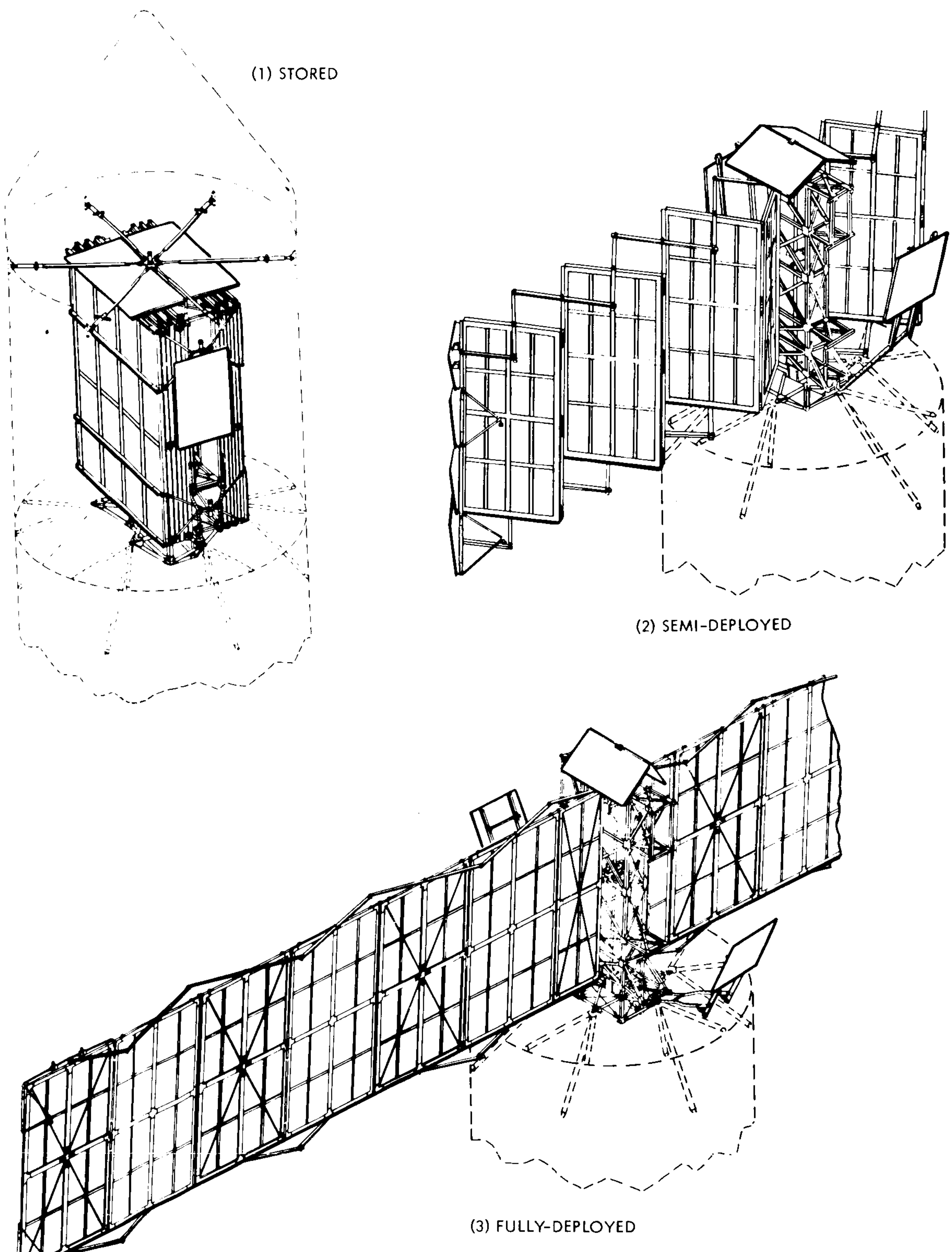

FIG. 1. PEGASUS SATELLITE

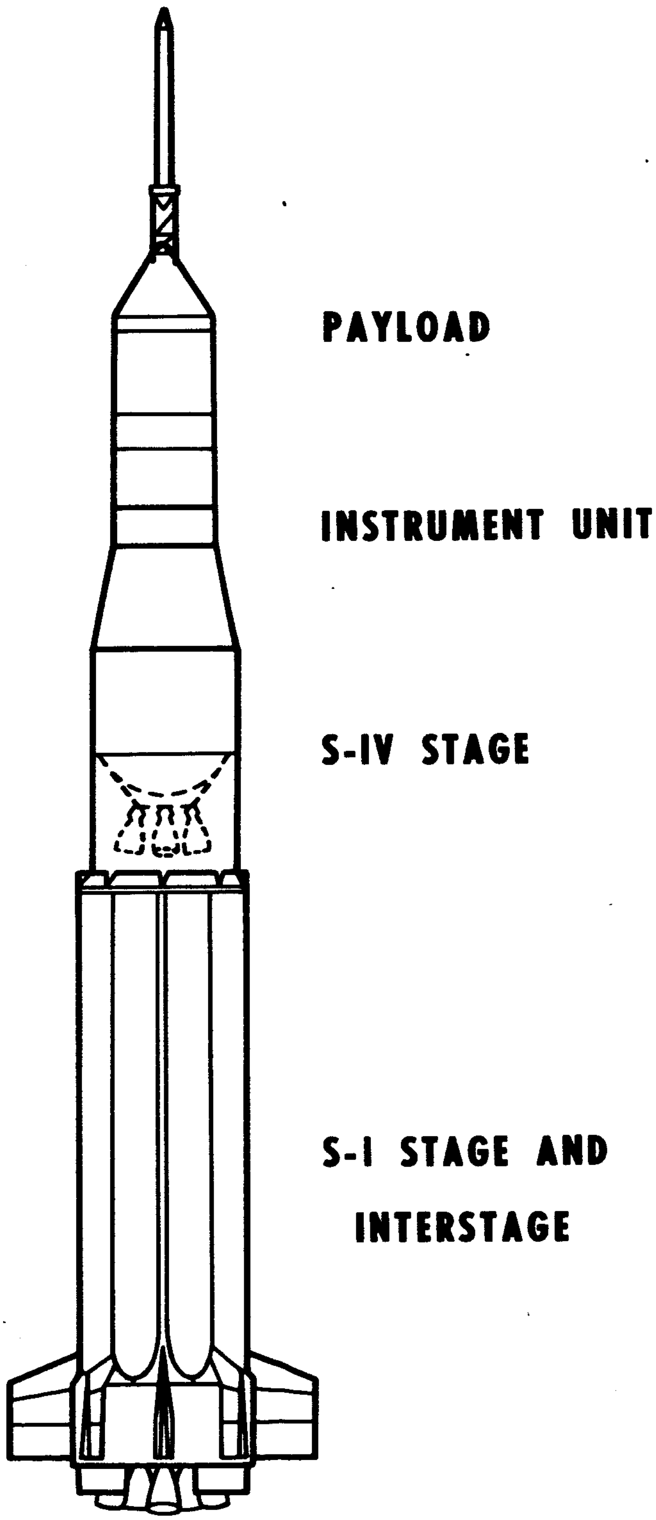

FIG. 2. SA-8 CONFIGURATION

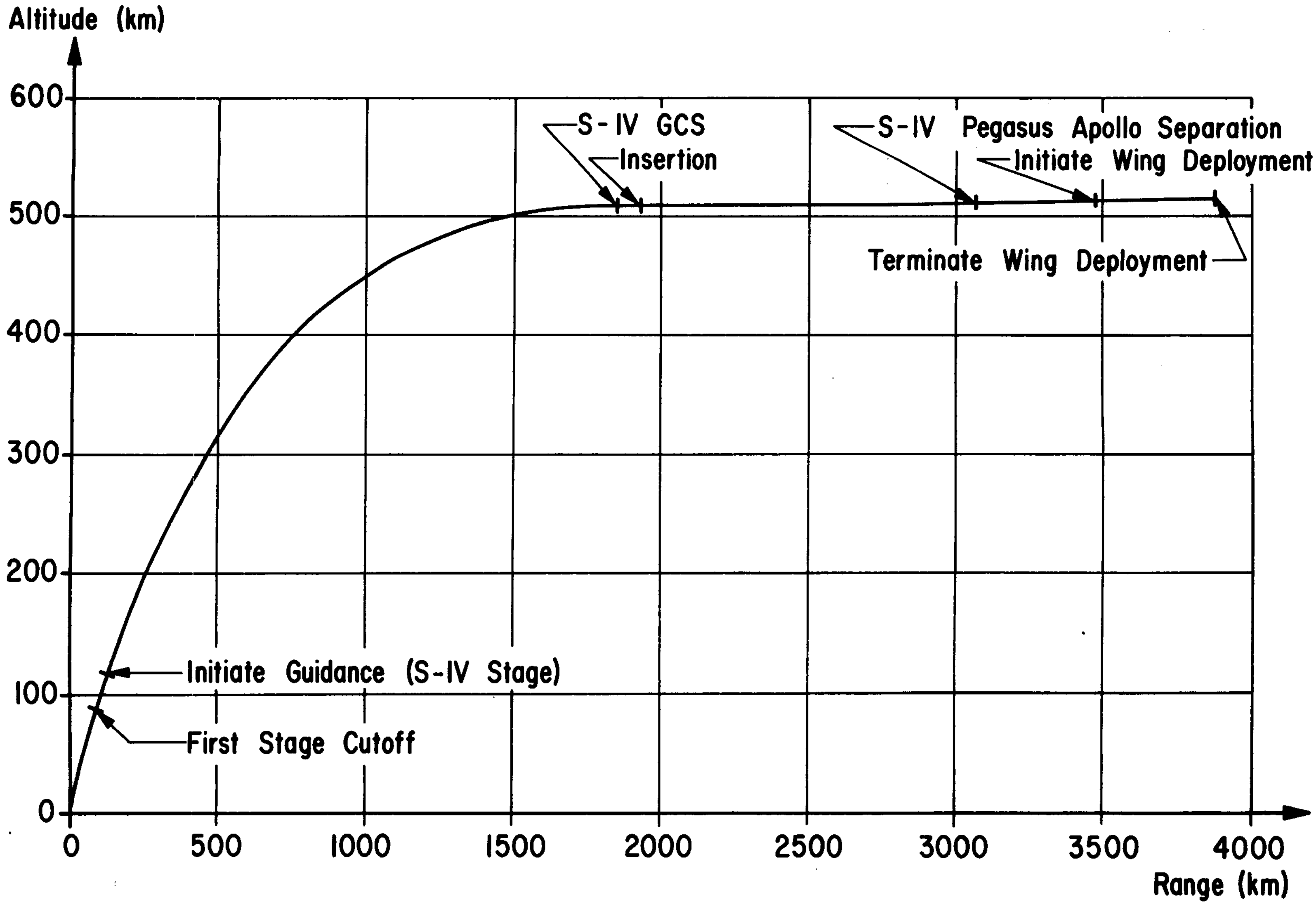

FIG. 3. ALTITUDE VERSUS RANGE

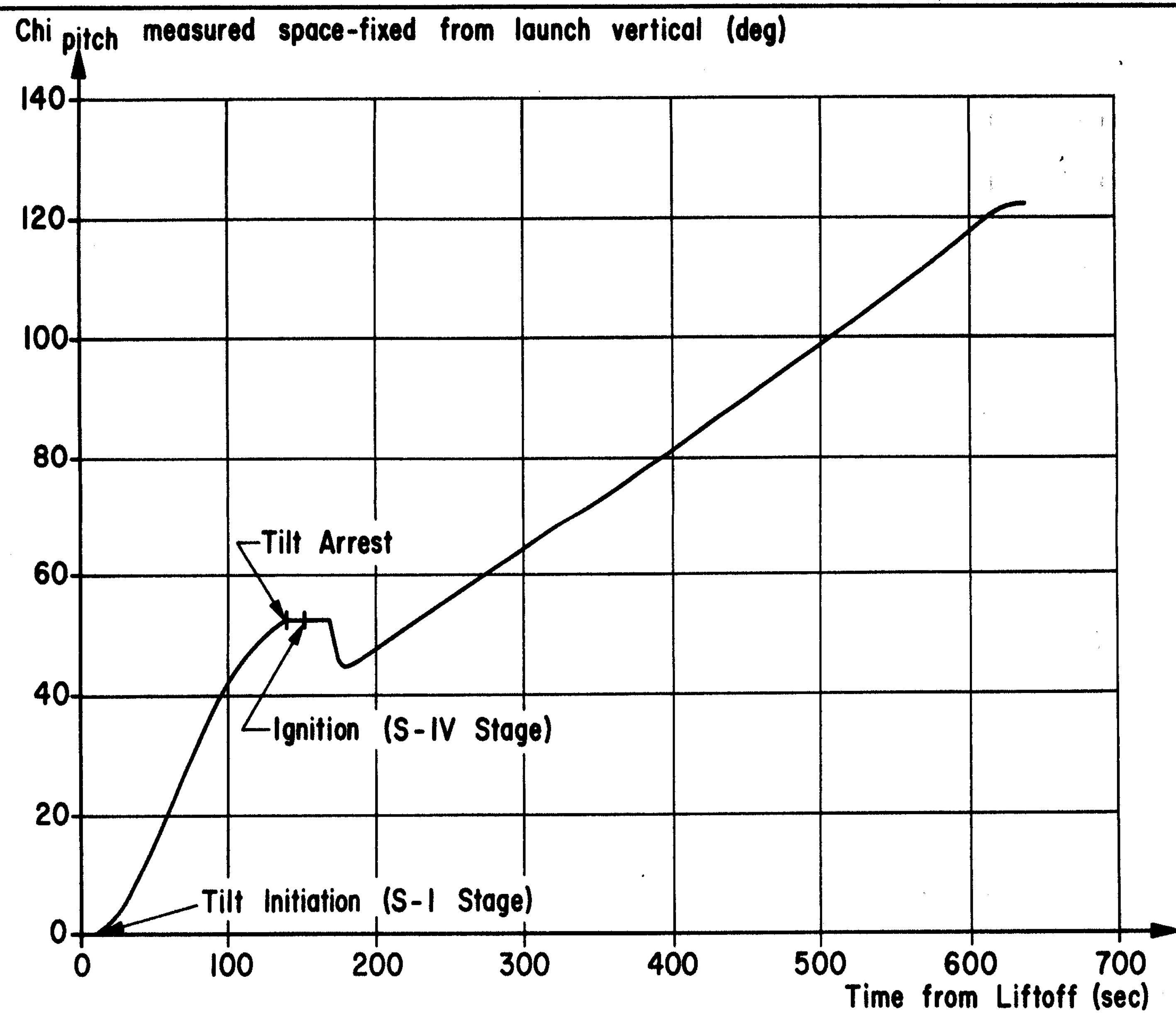

FIG. 4. CHI PITCH VERSUS TIME

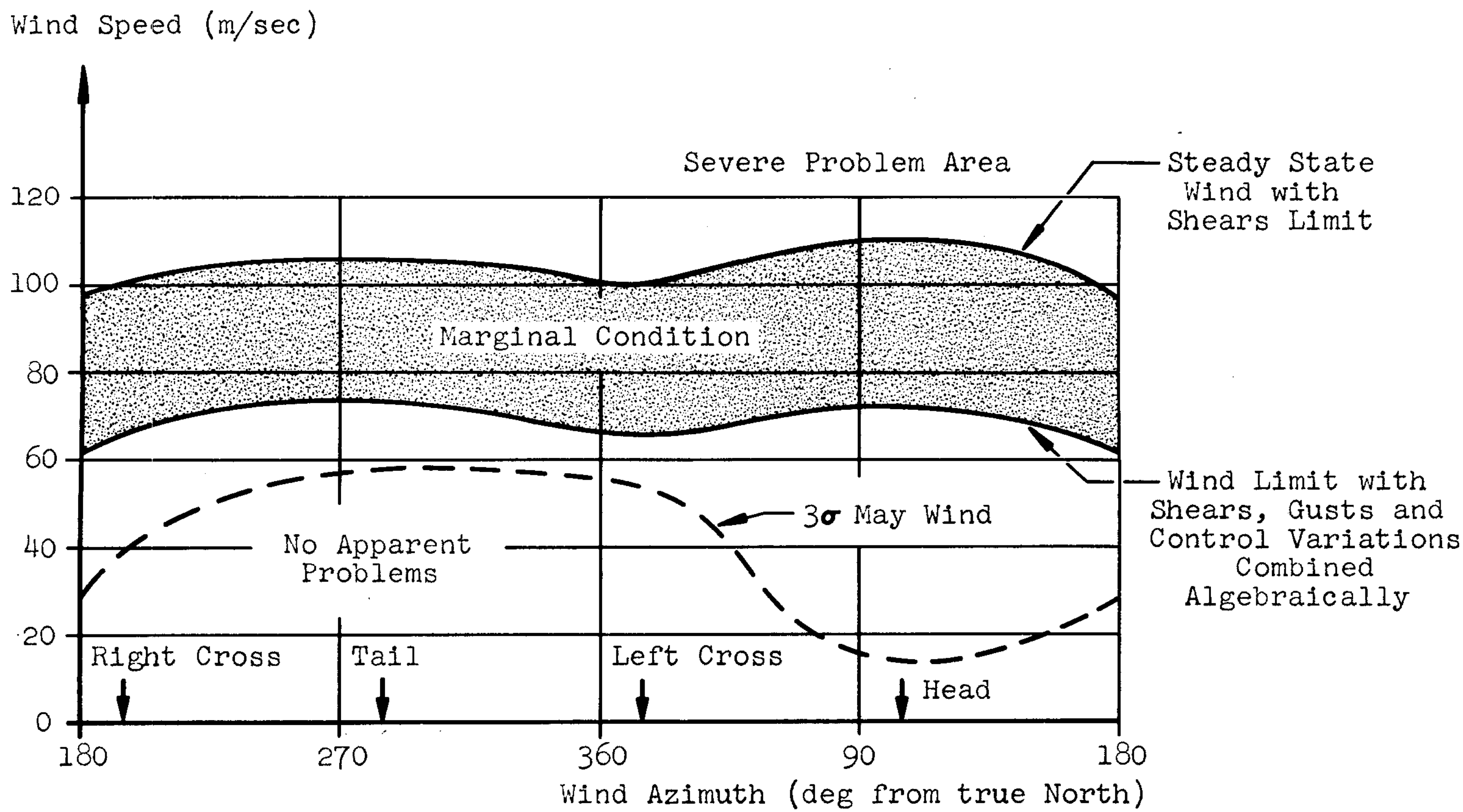

FIG. 5. SA-8 APPROXIMATE WIND SPEED LIMITS VERSUS WIND AZIMUTH FOR MAXIMUM DYNAMIC PRESSURE TIME POINT

APPENDIX A

Wind speed limits for the SA-8 vehicle have been determined for the maximum dynamic pressure region. These limits are established based on structural capabilities of the space vehicle as given by R-P&VE-SLL. Structural data furnished are functions angle of attack (α), gimbal angle (β), and dynamic pressure (q). Disturbances, other than the wind, used to establish these limits are 99% shears and gusts, 3σ C_1 and C_2 variations and $\pm$ 10% variation in the control gains.

Figure 5 shows the wind speed limits as a function of wind azimuth for the predicted maximum dynamic pressure time point. This figure shows the limits for various assumptions and combinations of disturbances upon which a decision for launch might be based. Wind magnitudes within the shaded portion of the curve could cause launch problems and a preflight simulation would be necessary for a launch decision. Wind magnitudes above the shaded portion could cause severe launch problems or make launch impossible. Wind magnitudes below the shaded portion create no apparent launch problems but, under exceptional conditions, even winds of this magnitude may still lead to structural problems; therefore, a limited amount of preflight simulation will still be performed.

APPENDIX B

The SA-8 post insertion venting analysis provides a 95.5% confidence level of not exceeding the 9 deg/sec roll and 2 deg/sec tumble rate limits outlined in Reference 6 . This analysis reflects the structural changes that are being incorporated for this vehicle; i, e., the interchange of O_2 and H_2 non-propulsive vents. It also includes the best estimate of impingement effects of vented H_2 gases on the Pegasus wing structure (based on SA-9 flight evaluation data), as well as perturbations due to misalignments, c.g. shifts, etc.

APPENDIX C

Range Safety Data for SA-8

The range safety data presented in Reference 7 consists of booster and LES impact areas, effects of range safety flight termination, land impact probabilities, injury probabilities, turning rate effects and other pertinent information.

The following parameters were varied to obtain the 3σ envelope for range safety purposes: thrust, flow rate, liftoff weight, and wind speed. Impact data for this envelope is given in tabular form and consists of instantaneous cutoff time, geodetic latitude, longitude, remaining flight time, and range along the earth's surface from launch to impact.

The vehicle velocity vector turning data for the nominal trajectory is graphically presented. In particular, the total velocity vector magnitude and orientation in the lateral direction is presented as a time function from the point of malfunction (engine gimbal deflection), applied in the yaw plane.

The probability of the S-IV stage dropping short of orbital insertion is .13. The probability of impacting on land can be calculated as follows:

$$P_I = \frac{\Delta t}{T_B} \times P_F$$

P_I = probability of impacting on land area

Δ_t = dwell time (IIP transit time)

T_B = total burn time of second stage

P_F = probability of any failure causing the 2nd stage to drop short

for SA-8: $P_I = 9.45 \times 10^{-4}$

APPENDIX C (CONT'D)

Subdividing the impact probabilities for individual countries:

Land Area	Dwell Time	Impact Probability
South West Africa	1.3	3.5×10^{-4}
Union South Africa	.8	2.1×10^{-4}
Bechuanaland	1.3	3.5×10^{-4}
Swaziland	.1	2.7×10^{-5}

The probability of injuring a person downrange can be determined in the following manner:

$$P_{IP} = P_I \times \frac{N}{L_A} \times A_L$$

where

P_{IP} = probability of injuring a person

$\frac{N}{L_A}$ = propulation density of country

A_L = lethal area

The probability of injuring a person by overflying land is:

$$P_{IP} = 2.4 \times 10^{-6}$$

The probability of injuring a person, subdivided by Nation

Nation	P_I	N/LA (Per Sq. Mi.)	PIP
South West Africa	3.5×10^{-4}	1	6.3×10^{-8}
Union South Africa	2.1×10^{-4}	24	9.0×10^{-7}
Bechuanaland	3.5×10^{-4}	1	6.3×10^{-8}
Swaziland	2.7×10^{-5}	28	1.4×10^{-7}

APPENDIX D. IGM TERMINAL CONDITIONS

The following defines the necessary IGM terminal conditions.

η_T	=	Terminal Radius Vector
$\dot{\eta}_T$	=	Terminal Time Rate Change of η_T
$\dot{\xi}_T$	=	Terminal Tangential Velocity
V_T	=	Terminal Total Velocity $(=\sqrt{+\ \dot{\eta}_T^2 + \dot{\xi}_T^2})$
$\ddot{\eta}_{gT}$	=	Terminal Radial Acceleration Due to Gravity
$\ddot{\xi}_{gT}$	=	Terminal Tangential Acceleration Due to Gravity
T'	=	Time-To-Go (initially)
V_{ex}	=	Exhaust Velocity ($g_o \cdot I_{sp}$)

The values for the above for SA-8 are as follows:

η_T	=	6884489.7 meters
$\dot{\eta}_T$	=	-0.90 meters/sec
$\dot{\xi}_T$	=	7671.5597 meters/sec
V_T	=	7671.5597 meters/sec
$\ddot{\eta}_{gT}$	=	-8.4158 meters/sec^2
$\ddot{\xi}_{gT}$	=	0
T'	=	465.0 sec (initially)
V_{ex}	=	4200.0 meters/sec

APPENDIX E. PREDICTED VEHICLE CHARACTERISTICS FOR FLIGHT EVALUATION COMPARISON

S-I Stage

The S-I thrust averages are obtained by considering the longitudinal components of thrust, reduced to sea level throughout flight. They are as follows:

$$F_T = F_1 + F_2$$

Where F_1 is the main engine thrust average and F_2 is the turbine exhaust thrust average.

F_1 = 6,749,611 newtons (1,517,373 lbf)

F_2 = 12,749 newtons (2,866 lbf)

F_T = 6,762,360 newtons (1,520,239 lbf)

The S-I flow rate is derived as follows:

$$\dot{W} \doteq \left[W_{(T=0)} - W_{(T=140)} - W_{aux} \right] / 140$$

Where W_{aux} = Ice, trapped environment, and chilldown

$\therefore \dot{W}_T$ = 2680 kg/sec (5908.2 lbs/sec)

I_{sp} = 257.3 sec

S-IV Stage

The S-IV stage thrust averages are vacuum values averaged from 1.8 second (when 90% thrust is achieved) to 476.2 seconds of S-IV flight time.

$$F_T = F_1 + F_2 + F_3$$

APPENDIX E. PREDICTED VEHICLE CHARACTERISTICS FOR FLIGHT EVALUATION COMPARISON (CONT'D)

Where F_1 is the engine thrust along longitudinal axis = 400002 newtons (89924 lbf)

F_2 = Thrust due to cluster effect = -2798 newtons (-629 lbf)

F_3 = Helium heater and chilldown thrust = 734 newtons (165 lbf)

F_T = 397, 938 newtons (89, 460 lbf)

The flow rate is also obtained from 1. 8 seconds to 476. 2 seconds of S-IV flight time.

$\dot{W}_T$ = 95 kg/sec (210.4 lbs/sec)

I_{sp} = 425. 2 sec

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6. I-I/IB-P-65-156, "Angular Rate Limits for SA-8 Pegasus Satellite," March 30, 1965.

7. Range Safety Data Report #3-65, "Range Safety Data for Saturn SA-8," April 22, 1965.

APPROVAL

SA-8 OPERATIONAL TRAJECTORY

By

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and
Gordon W. Solmon

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 unclassified.

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