Z65·10577

CCN

~~CONFIDENTIAL~~

(ACCESSION NUMBER) (THRU)

57 None

(PAGES) (CODE)

NASA CR-117662

(NASA CR OR TMX OR AD NUMBER) (CATEGORY)

FF No. 602(A)

AVAILABLE TO NASA OFFICES AND NASA RESEARCH CENTERS ONLY

APOLLO

(NASA-CR-117662) APOLLO SUPPORT PROGRAM: SOME TRAJECTORY CONSIDERATIONS FOR APOLLO SUPER-ORBITAL RE-ENTRY TESTS (General Electric Co.) 57 p

N75-75497

Unclas

00/98 28339

SUPPORT PROGRAM

SOME TRAJECTORY CONSIDERATIONS FOR APOLLO SUPER-ORBITAL RE-ENTRY TESTS

JUL 1975 RECEIVED NASA STI FACILITY INPUT BRANCH

Report APSO-VE-101

Contract NASw 410

AVAILABLE TO NASA HEADQUARTERS ONLY

GE-APSO-VE-101

13 August 1962

DSD DEFENSE SYSTEMS DEPARTMENT • SYRACUSE, N.Y.

GENERAL ELECTRIC

~~CONFIDENTIAL~~

[redacted]

#2

Report APSO-VE-101
Contract NASw-410

CLASSIFICATION CHANGE
To UNCLASSIFIED
By authority of NASA TD 75-406
Changed by [illegible] Date 7/23/75
Classified Document Master Control Station, NASA
Scientific and Technical Information Facility

APOLLO
SUPPORT PROGRAM

SOME TRAJECTORY CONSIDERATIONS FOR APOLLO SUPER-ORBITAL RE-ENTRY TESTS (U)

13 August 1962

Authority: Letter Contract
Contract NASw-410

[redacted]

NOTICE: This material contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18 U.S.C., Sections 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

RECEIVED
JAN 8 1963
MEA
DOCUMENT
CENTER

By
R. Becker

Propulsion Engineering
Defense Systems Department
General Electric Company
Syracuse, New York

[redacted]

Report APSO-VE-101
Contract NASw-410

DISTRIBUTION LIST

	Copies
OMSF Attn: MPR C	25
Deputy Director for Systems	15
Contracting Officer	2
General Electric Co.	
Contract Administration	1
System Programming	1
General Manager - Apollo Program Support Operation	1
General Manager - DED	1
General Manager - DSD	1
Manager - Integration Support	10
Manager - Reliability Assessment	3
Manager - System Checkout	3
Manager - Marketing, APSO	3
Manager - Vehicular Engineering	10
Manager - I&GPS	3
Manager - Electronic Systems Engineering	1
Manager - Finance, APSO	1
Apollo DDCS	21

Report APSO-VE-101
Contract NASw-410

ABSTRACT

This report describes the study of five Saturn C1 launch vehicle configurations for the Apollo super-orbital re-entry tests. The study included computation of trajectories and evaluation of performance of the five vehicle configurations, as well as an assessment of payload weight and velocity that can be achieved under re-entry conditions. The necessity for considerable reduction in the payload weight to achieve the velocity required was disclosed by this study.

TABLE OF CONTENTS

Paragraph	Page
SUMMARY	1
INTRODUCTION	2
CALCULATION PROCEDURE	3
COMPUTER PROGRAM	3
GENERAL METHOD	5
DETAILED DESCRIPTION	6
INTRODUCTION	6
CONFIGURATION NO. 1	6
CONFIGURATION NO. 2	12
CONFIGURATION NO. 3	12
CONFIGURATION NO. 4	12
CONFIGURATION NO. 5	20
RESULTS	23
ADDITIONAL CONSIDERATIONS	26
REFERENCES	28
APPENDIX A - SAMPLE DIGITAL PRINTOUT FOR LAUNCH VEHICLE CONFIGURATION NO. 4	A-1

LIST OF ILLUSTRATIONS

Figure	Title	Page
1	Curves of Altitude versus Range for the Five Launch Vehicle Configurations Studied	9
2	Significant Trajectory Parameters versus Time for Configuration No. 1	10
3	Payload Weight versus Velocity for Configurations No. 1 and No. 2	11
4	Significant Trajectory Parameters versus Time for Configuration No. 2	13
5	Significant Trajectory Parameters versus Time for Configuration No. 3	15
6	Payload Weight versus Velocity for Configurations No. 3 and No. 4	17
7	Significant Trajectory Parameters versus Time for Configuration No. 4	18
8	Significant Trajectory Parameters versus Time for Configuration No. 5	21

LIST OF TABLES

Table	Title	Page
1	Five Launch Vehicle Configurations and Re-entry Velocities for a 10,000-lb Payload	7
2	Performance Parameters of the Various Stages Used in the Five Launch Vehicle Configurations	7
3	Summary of Performance Parameters for the Best Trajectory Obtained for Configuration No. 1	8
4	Summary of Performance Parameters for the Best Trajectory Obtained for Configuration No. 2	14
5	Summary of Performance Parameters for the Best Trajectory Obtained for Configuration No. 3	16
6	Summary of Performance Parameters for the Best Trajectory Obtained for Configuration No. 4	19

LIST OF TABLES (CONT.)

Table	Title	Page
7	Summary of Performance Parameters for the Best Trajectory Obtained for Configuration No. 5	22
8	Tabulation of the Stage Burnout and Re-entry Conditions for Some Typical Trajectories Obtained for Each of the Launch Vehicle Configurations Studied	24
9	Typical Set of Data Illustrating Sensitivity of Re-entry Point to Thrust Vector Pitch Rate	25

LIST OF SYMBOLS

h	Altitude above the surface of the earth
F	Engine thrust
g_o	Gravitational acceleration constant
I_{sp}	Specific impulse
P/L	Payload weight
S/M	Service module
V	Velocity
ΔV_{actual}	Stage velocity gain
$\Delta V_{gravity}$	Velocity loss caused by gravity
ΔV_{drag}	Velocity loss caused by drag
ΔV_{α}	Velocity loss caused by angle of attack
ΔV_{ideal}	Stage ideal velocity $\left(\Delta V_{ideal} = I_{sp}\, g_o \ln \frac{W_o}{W_e}\right)$
W_o	Initial weight
W_p	Propellant weight
W_e	Empty weight
α	Angle of attack between thrust vector and velocity vector
γ	Path angle, measured for local vertical to velocity vector
Ψ	Thrust attitude angle measured from launch vertical
$\dot{\Psi}$	Rate of change of thrust attitude angle
ϵ_k	First-stage kick angle

SUMMARY

Trajectories and performance were computed for the following five launch vehicles considered for use in the NASA super-orbital re-entry tests of the Apollo command module.

Vehicle	Stages
1	S-I + S-IVB
2	S-I + S-IVC
3	S-I + S-IVC + Storable Service Module
4	S-I + S-IVB + S-V
5	S-I + S-IVB + High-Energy Service Module

The trajectories were calculated by using existing two-dimensional flight programs on an IBM 7090 computer, with vehicle parameters adjusted to intercept a re-entry point of 400,000 feet altitude and an angle of -5.3 degrees, at a velocity that approached 36,000 feet per second as closely as possible. The trajectories were not optimized because of time limitations and those of existing programs, but the results summarized in this report are considered representative of the performance which can be achieved with each of the vehicles studied.

INTRODUCTION

The Office of Manned Space Flight of the National Aeronautics and Space Administration Headquarters has been considering the requirements and implementation of the Apollo Super-Orbital Velocity Re-entry Test Program. As a part of this program coordination, the performance of the Saturn-C1 class of vehicles, potentially available in the time period of the proposed tests, is being considered to assess payload weight and the velocity that can be achieved under re-entry conditions. This report provides information pertinent to the study to supplement the work now in progress at the various NASA facilities.

CALCULATION PROCEDURE

COMPUTER PROGRAM

A spherical, non-rotating earth is assumed, with the flight path in a single plane passing through the center of the earth. The missile is launched vertically, and after 20 seconds a specified kick angle is applied. A gravity-turn (zero angle of attack) flight is then flown for the duration of first-stage powered flight. At second-stage ignition, a linear thrust attitude control program may be inserted or the gravity turn may be flown throughout the powered flight. Coast phases for specified time periods may be inserted only between burning stages (interrupted stage burning was not considered).

The missile is considered as a point mass, and the four differential equations of motion (References 1 and 2) are solved, by using the Runge-Kutta method, to give a continuous record of altitude, earth range, velocity, and acceleration. Each stage burns at a prescribed fixed rate until the propellant in that stage is exhausted. Then the empty weight of that stage is separated and the following stage is fired, with the burnout conditions of the preceding stage serving as initial conditions. Atmosphere computations are based on the 1959 ARDC model atmosphere and a drag coefficient versus Mach number table submitted by the user. For this study the following tabulation was used:

Mach Number	Drag Coefficient
0	1.000
0.560	0.2900
1.000	0.7100
1.222	0.7300
2.000	0.4700
3.000	0.3000
4.000	0.2100
5.000	0.1700
6.000	0.1300
7.000	0.1100

Drag data were included only during the first-stage powered flight.

At burnout of the final stage, apogee and impact data are computed by using Kepler's equations and assuming a ballistic trajectory to impact. Also computed are the orbit parameters: semi-major axis, eccentricity, and period. One may also select intermediate tabulation of parameter values during free flight to apogee or impact.

A typical set of the complete digital computer printout is included in Appendix A, to illustrate detailed trajectory information for Configuration No. 4.

GENERAL METHOD

Since the first-stage flight was vertical for 20 seconds followed by a gravity turn, the only variable involved during first-stage flight was the kick angle (ϵ_k) applied at the end of the vertical flight (t = 20 seconds). At first-stage burnout, a coast period could be inserted if desired. The upper stages were then flown with a linear thrust attitude program which was specified by two variables: (1) The initial thrust vector angle (Ψ_o), and (2) the rate of change of the thrust vector angle ($\dot{\Psi}$). For the three-stage launch vehicle configurations, a coast phase could also be inserted between the second- and third-stage powered phases.

For each configuration, various combinations of the variables involved (ϵ_k, Ψ_o, $\dot{\Psi}$) were considered, and several combinations were found which yield trajectories that satisfy the specified re-entry conditions of a path angle of -5.3 degrees at an altitude of 400,000 feet. The trajectory that met these specified end-conditions and produced the highest velocity was assumed to be the best trajectory for that particular launch vehicle configuration. For each configuration there are many combinations that would produce trajectories that would also satisfy the required end-conditions, but it was impractical to investigate all combinations with the existing computer program.

If time had permitted, the more nearly optimum trajectories could be derived by using calculus of variations methods. However, such a program was not available at the time of this study. Further, it is assumed that the trajectories selected are adequate to indicate the type of performance achievable with each launch vehicle configuration.

DETAILED DESCRIPTION

INTRODUCTION

Table 1 defines the five launch vehicle configurations studied. Table 2 shows the performance parameters such as thrust, specific impulse, propellant weight, and empty weight for the various stages used in the five launch vehicle configurations. In all cases, the thrust-to-weight ratio at launch was 1.25. This in turn fixed the gross weight at lift-off at 1,210,000 pounds.

Figure 1 is a curve of altitude versus range for the best trajectory obtained for each configuration.

CONFIGURATION NO. 1

This configuration is a two-stage vehicle consisting of the S-I first stage and the S-IVB second stage. The computer trajectories for this configuration were based on a payload of 10,523 pounds, and the assumption that the first stage was fully loaded and propellant was off-loaded from the second stage, in order not to exceed the maximum launch gross weight of 1,210,000 pounds. Figure 2 is a plot of the significant trajectory parameters for the best trajectory obtained for this configuration. Table 3 lists the stage weights, propellants consumed, and velocities calculated for this case. The ideal velocity was 35,786 feet per second, and the actual velocity was 30,100 feet per second.

If the second stage is fully loaded and the first stage is off-loaded, the ideal velocity for this configuration would increase to 37,116 feet per second for a payload of 10,000 pounds. Assuming that the velocity losses for this propellant loading would be the same as for the computed case, this would then indicate an actual velocity of 31,430 feet per second. Figure 3 shows the estimated variation of actual velocity with payload for Configuration No. 1, for the case of the fully loaded second stage and off-loaded first stage.

Table 1

Five Launch Vehicle Configurations and Re-entry Velocities for a 10,000-lb Payload

Configuration	Stages	Approximate Velocity at Re-entry Point for 10,000-lb Payload
1	S-I + S-IVB	31,430
2	S-I + S-IVC	31,625
3	S-I + S-IVC + S/M (Storable)	30,080
4	S-I + S-IVB + S-V	33,700
5	S-I + S-IVB + S/M (High Energy)	32,910

Table 2

Performance Parameters of the Various Stages Used in the Five Launch Vehicle Configurations

	S-I	S-IVB	S-IVC	S-V	(Storable) S/M	(High Energy) S/M
Thrust (sea level) (lbs)	1,513,000	-	-	-	-	-
Thrust (vacuum) (lbs)	1,693,400	200,000	400,000	30,000	21,500	15,000
Specific Impulse (sea level) (sec)	255.4	-	-	-	-	-
Specific Impulse (vacuum) (sec)	286	422	420	420	315	420
Propellant Weight (fully loaded) (lbs)	850,000	230,000	330,000	30,000	39,930	15,000
Empty Weight (lbs)	131,200	25,833	34,128	5,000	10,754	5,000
Total Effective Exhaust Area (ft^2)	85.255	32.5	65.0	-	-	-

Table 3

Summary of Performance Parameters for the Best Trajectory Obtained for Configuration No. 1

Configuration No. 1			
First-Stage Kick Angle = 1.0 degree			
Second-Stage Thrust Vector Program:			
Ψ_o = 55 degrees			
$\dot{\Psi}$ = 0.1548 degree/sec			
R/E Conditions	(Payload Wt. = 10,523 lbs)		
h = 400,000 ft			
γ = 95.8 degrees			
V = 30,100 ft/sec			
S-I Stage			
ΔV_{actual} = 6637 ft/sec		W_p = 850,955 lbs	
$\Delta V_{gravity}$ = -3883 ft/sec		W_e = 130,245 lbs	
ΔV_{drag} = - 294 ft/sec		Avg. I_{sp} = 273 sec	
ΔV_{α} = 0 ft/sec			
ΔV_{ideal} = 10,814 ft/sec			
S-IVB Stage			
ΔV_{actual} = 23,431 ft/sec		W_p = 192,444 lbs (off-loaded)	
$\Delta V_{gravity}$ = -1,468 ft/sec		W_e = 25,833 lbs	
ΔV_{drag} = 0 ft/sec		I_{sp} = 422 sec	
ΔV_{α} = - 73 ft/sec			
ΔV_{ideal} = 24,972 ft/sec			
Coast			
Velocity Increase = 32 ft/sec			
Total: V_{ideal} = 35,786 ft/sec		Combined Velocity Loss = 5,686 ft/sec	
V_{actual} = 30,100 ft/sec			

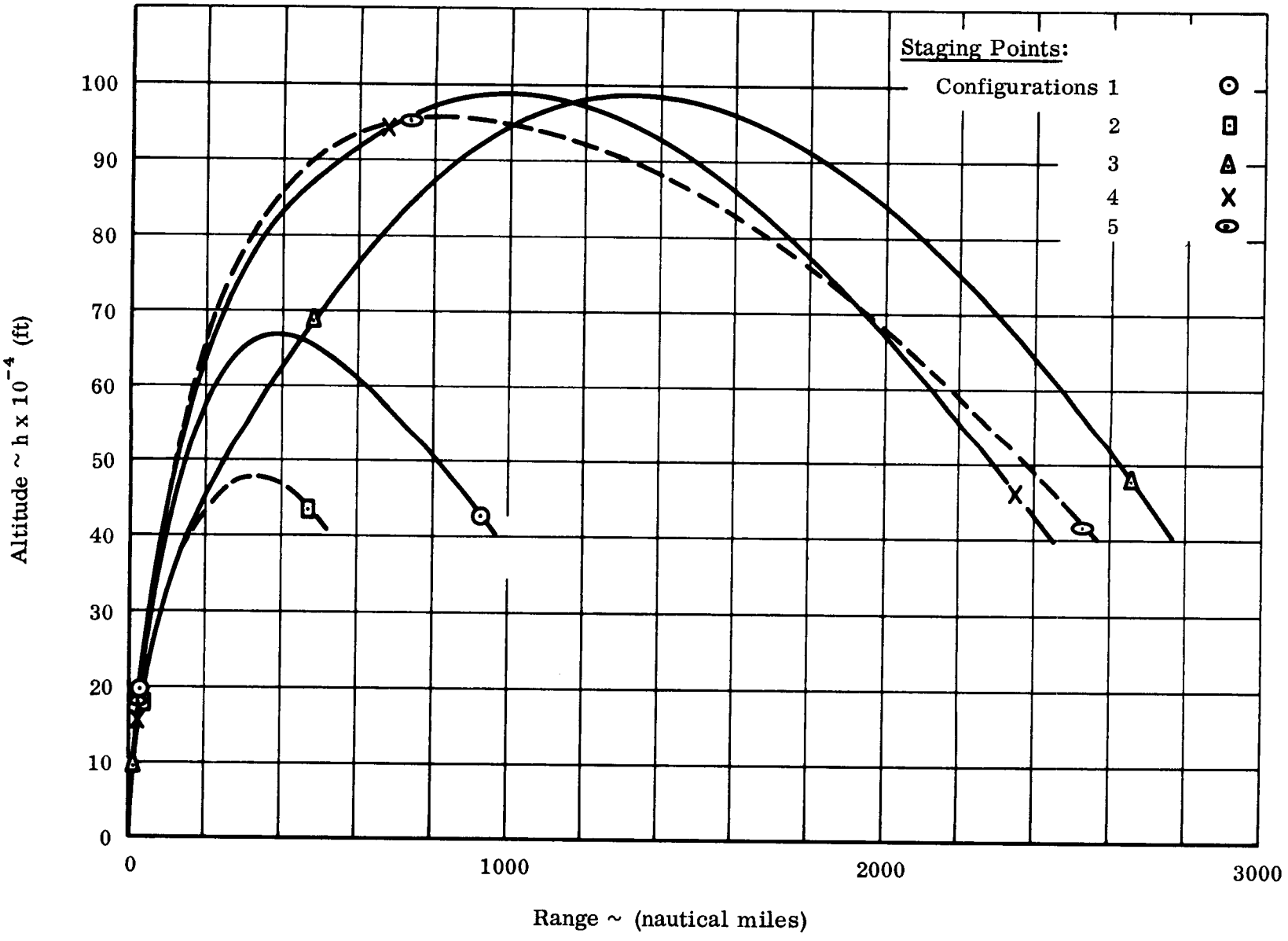

Figure 1. Curves of Altitude versus Range for the Five Launch Vehicle Configurations Studied

[redacted]

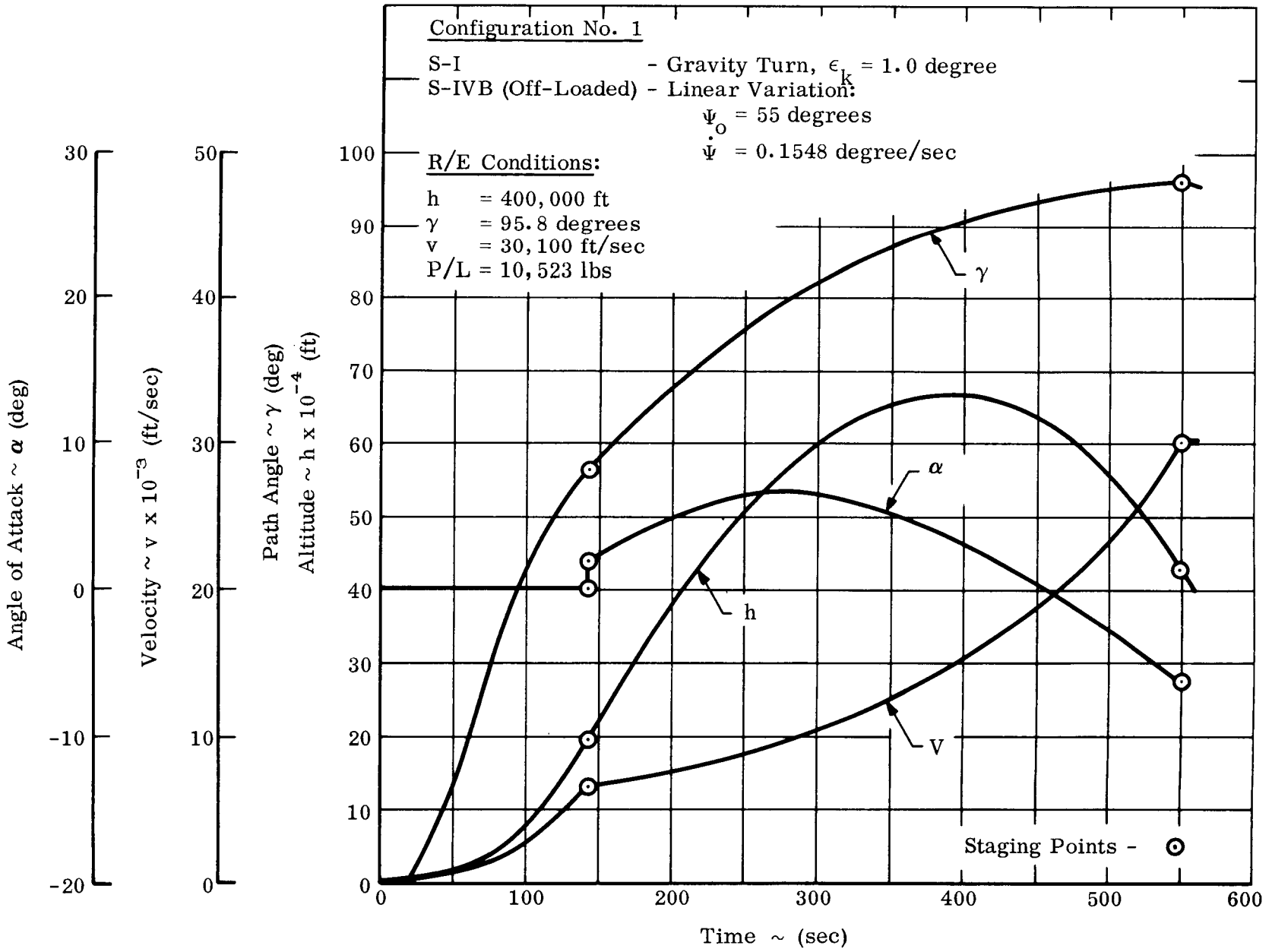

Figure 2. Significant Trajectory Parameters versus Time for Configuration No. 1

[redacted]

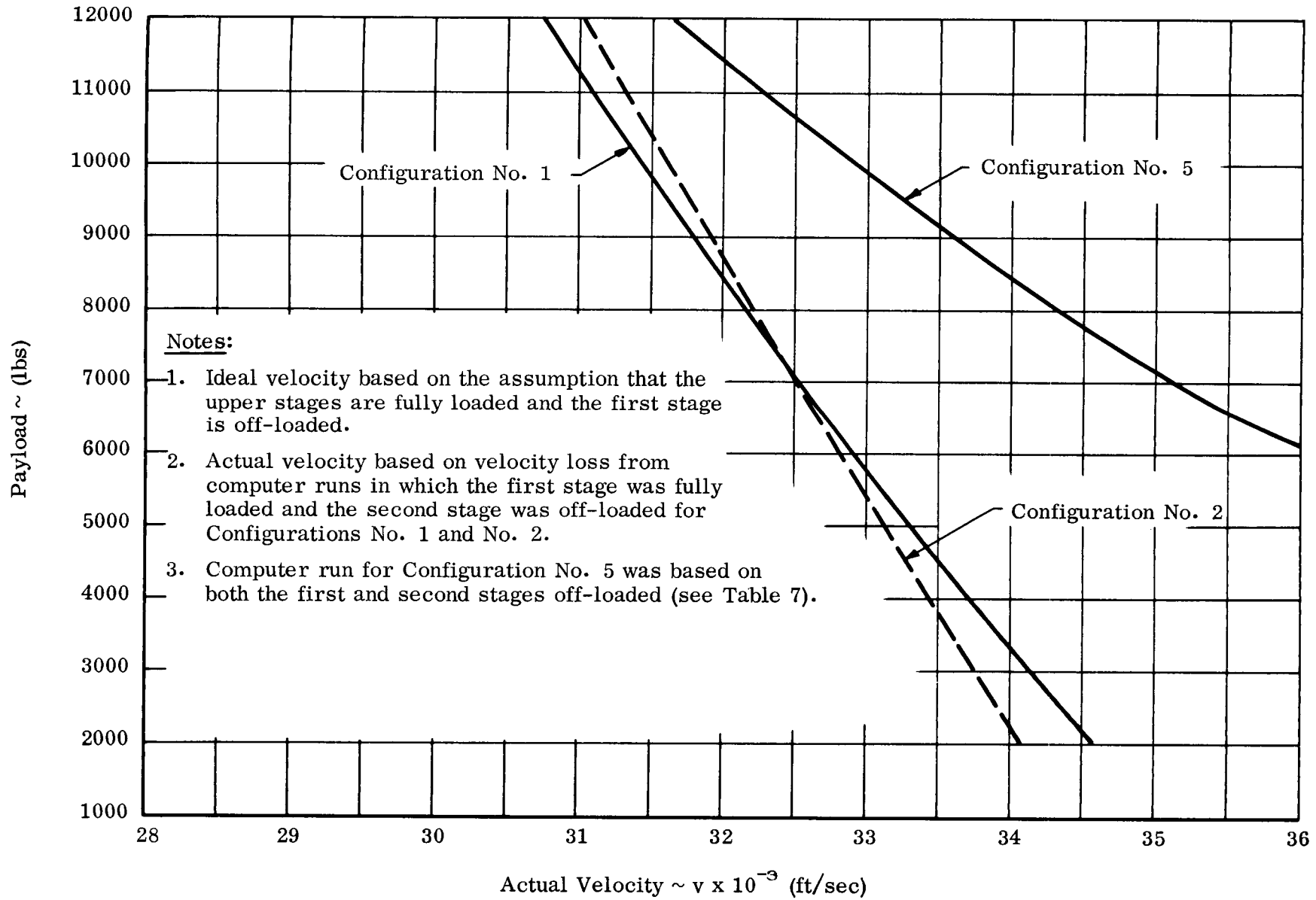

Figure 3. Payload Weight versus Velocity for Configurations No. 1 and No. 2

CONFIGURATION NO. 2

This configuration is also a two-stage vehicle with the S-I first stage and the S-IVC second stage. As in the case of Configuration No. 1, the computer trajectories for this vehicle were based on off-loading the second stage and a payload weight of 10,007 pounds. The best trajectory obtained for this configuration is shown in Figure 4, and the important performance parameters are summarized in Table 4. With the second stage off-loaded, the ideal velocity is 33,174 feet per second and the actual velocity is 27,950 feet per second.

For the fully loaded second stage, ideal velocity increases to 36,849 feet per second for a payload of 10,000 pounds. The corresponding actual velocity would then be 31,625 feet per second assuming that velocity losses are unchanged. Figure 3 shows the variation of actual velocity with payload for the latter launch vehicle propellant loading.

CONFIGURATION NO. 3

This configuration is a three-stage vehicle consisting of the S-I first stage, the S-IVC second stage, and a service module utilizing storable propellants as the third stage. All data for this vehicle were obtained for a payload of 10,589 pounds by assuming the upper stages to be fully loaded and the first stage off-loaded. The best trajectory obtained for this vehicle is illustrated in Figure 5 and Table 5. Figure 6 shows the variation of actual velocity with payload for this configuration. The curve is based on computer data for a payload of 10,589 pounds. The other points on the curve were calculated by hand with constant velocity loss.

CONFIGURATION NO. 4

Configuration No. 4 is a three-stage vehicle consisting of the S-I first stage, the S-IVB second stage and the S-V third stage. The computer data for this vehicle were based on a payload of 9970 pounds and the assumption that the upper stages were fully loaded with the first stage off-loaded. The best trajectory obtained for this vehicle is described in Figure 7 and Table 6. Based on this computer point a curve of the variation of actual velocity versus payload weight was generated (Figure 6). The computer printout for this configuration is included in Appendix A.

[redacted]

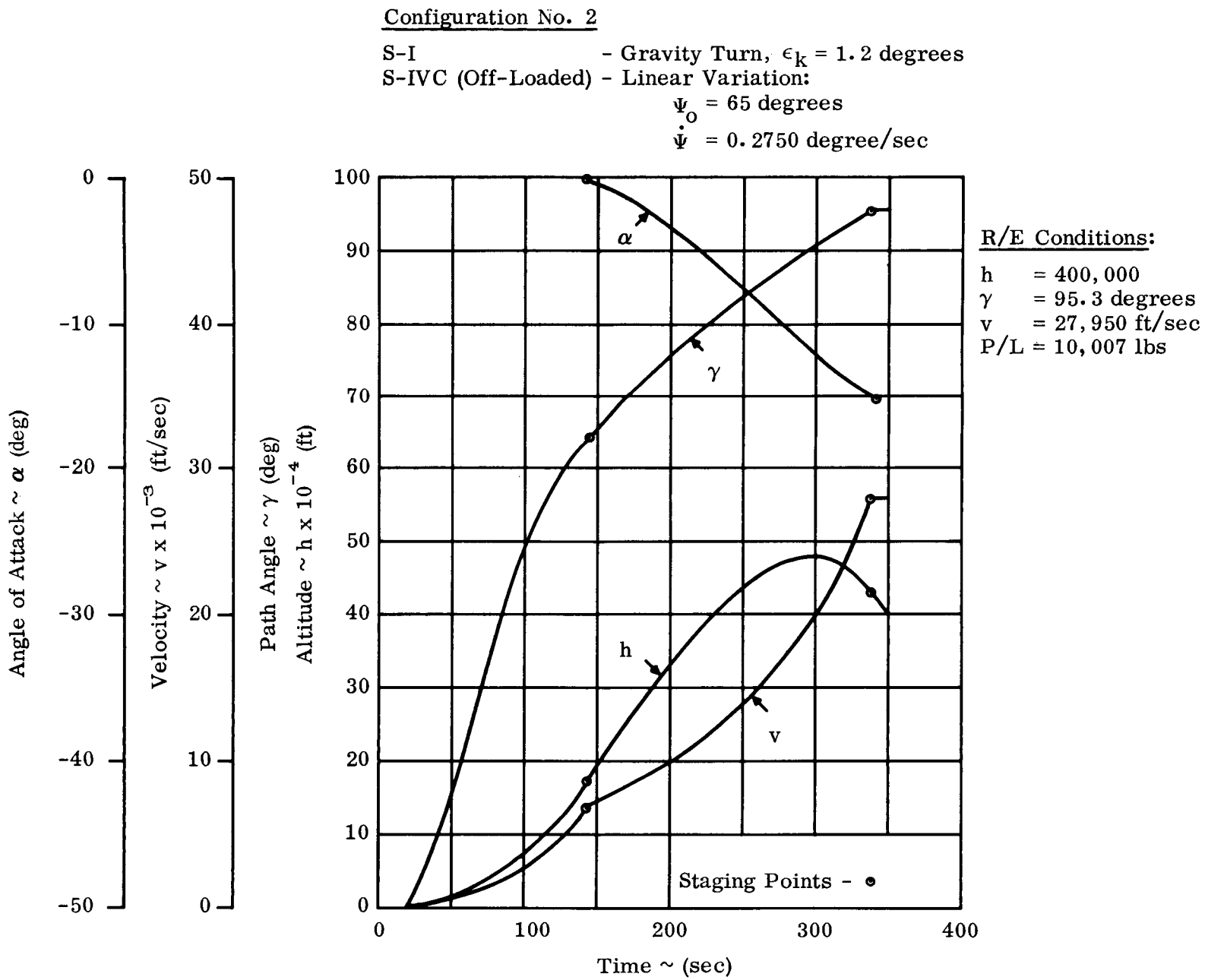

Figure 4. Significant Trajectory Parameters versus Time for Configuration No. 2

[redacted]

Table 4

Summary of Performance Parameters for the Best Trajectory Obtained for Configuration No. 2

Configuration No. 2			
First-Stage Kick Angle = 1.2 degrees			
Second-Stage Thrust Vector Program:			
Ψ_o = 65 degrees			
$\dot{\Psi}$ = 0.2750 degree/sec			
R/E Conditions		(Payload Wt. = 10,007 lbs)	
h = 400,000 ft			
γ = 95.3 degrees			
V = 27,950 ft/sec			
S-I Stage			
ΔV_{actual}	= 6,832 ft/sec	W_p	= 850,955 lbs
$\Delta V_{gravity}$	= -3,663 ft/sec	W_e	= 130,245 lbs
ΔV_{drag}	= - 316 ft/sec	Avg. I_{sp}	= 273 sec
ΔV_{α}	= 0 ft/sec		
ΔV_{ideal}	= 10,811 ft/sec		
S-IVB Stage			
ΔV_{actual}	= 21,086 ft/sec	W_p	= 184,665 lbs (off-loaded)
$\Delta V_{gravity}$	= -912 ft/sec	W_e	= 34,128 lbs
ΔV_{drag}	= 0 ft/sec	I_{sp}	= 422 sec
ΔV_{α}	= -365 ft/sec		
ΔV_{ideal}	= 22,363 ft/sec		
Coast			
Velocity Increase = 32 ft/sec			
Total: V_{ideal}	= 33,174 ft/sec		
V_{actual}	= 27,950 ft/sec		
Combined Velocity Loss = 5224 ft/sec			

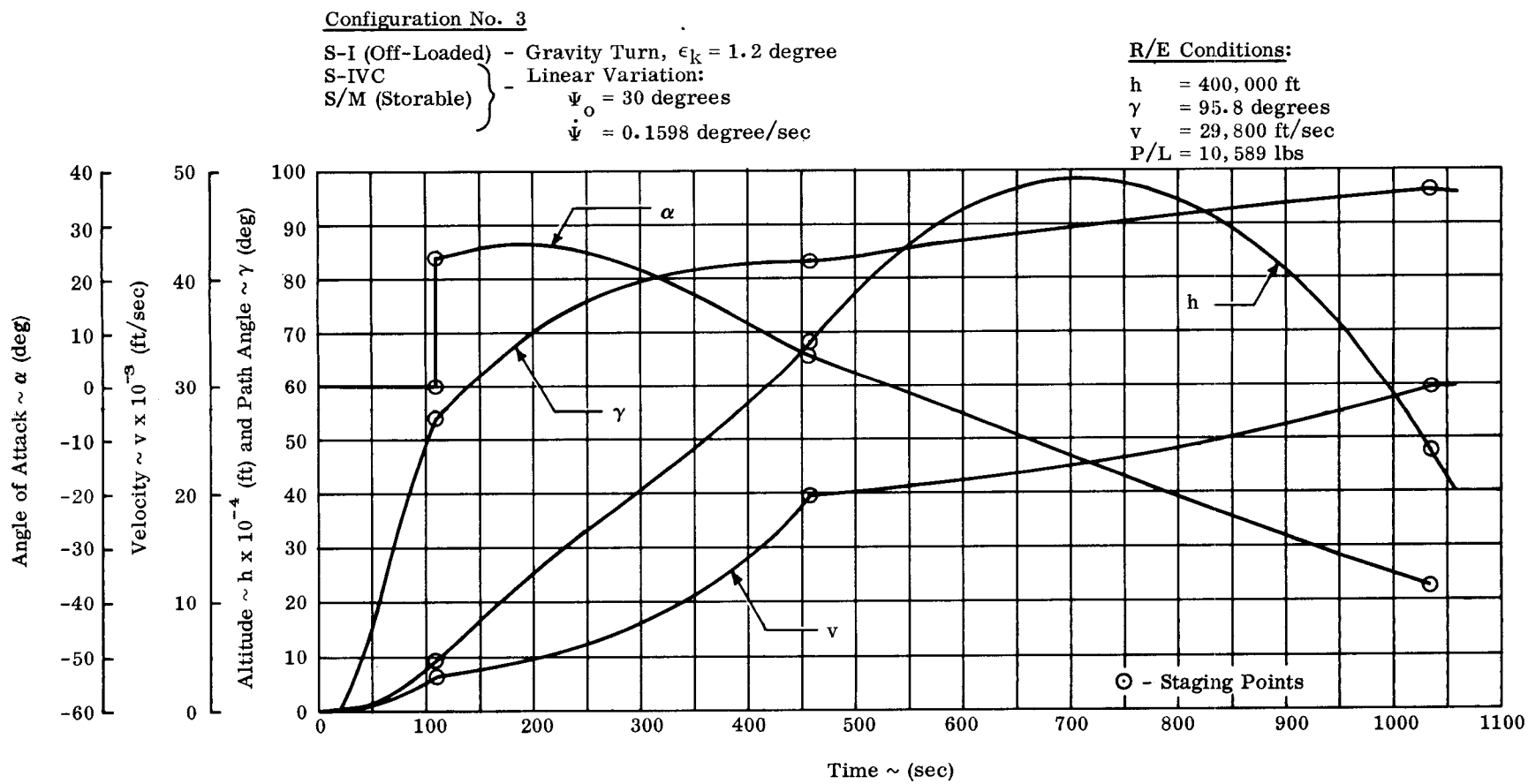

Figure 5. Significant Trajectory Parameters versus Time for Configuration No. 3

Table 5

Summary of Performance Parameters for the Best Trajectory Obtained for Configuration No. 3

Configuration No. 3							
First-Stage Kick Angle = 1.2 degrees Second- and Third-Stage Thrust Vector Program: Ψ_o = 30 degrees $\dot{\Psi}$ = 0.1598 degree/sec							
R/E Conditions (Payload Wt. = 10,589 lbs) h = 400,000 ft γ = 95.8 degrees V = 29,800 ft/sec							
S-I Stage							
ΔV_{actual}	=	3371 ft/sec	ΔV_{α}	= 0 ft/sec	W_p	=	653,486 lbs (off-loaded)
$\Delta V_{gravity}$	=	-3127 ft/sec	ΔV_{ideal}	= 6796 ft/sec	W_e	=	131,702 lbs
ΔV_{drag}	=	- 298 ft/sec			Avg. I_{sp}	=	270 sec
S-IVC Stage							
ΔV_{actual}	=	16,503 ft/sec	ΔV_{α}	= -1,073 ft/sec	W_p	=	329,745 lbs
$\Delta V_{gravity}$	=	-2,769 ft/sec	ΔV_{ideal}	= 20,345 ft/sec	W_e	=	34,382 lbs
ΔV_{drag}	=	0 ft/sec			I_{sp}	=	422 sec
S/M (Storable)							
ΔV_{actual}	=	9,844 ft/sec	ΔV_{α}	= -870 ft/sec	W_p	=	39,341 lbs
$\Delta V_{gravity}$	=	+131 ft/sec	ΔV_{ideal}	= 10,583 ft/sec	W_e	=	10,754 lbs
ΔV_{drag}	=	0 ft/sec			I_{sp}	=	315 sec
Coast Velocity Increase = 82 ft/sec Total: ΔV_{ideal} = 37,724 ft/sec ΔV_{actual} = 29,800 ft/sec Combined Velocity Loss = 7,924 ft/sec							

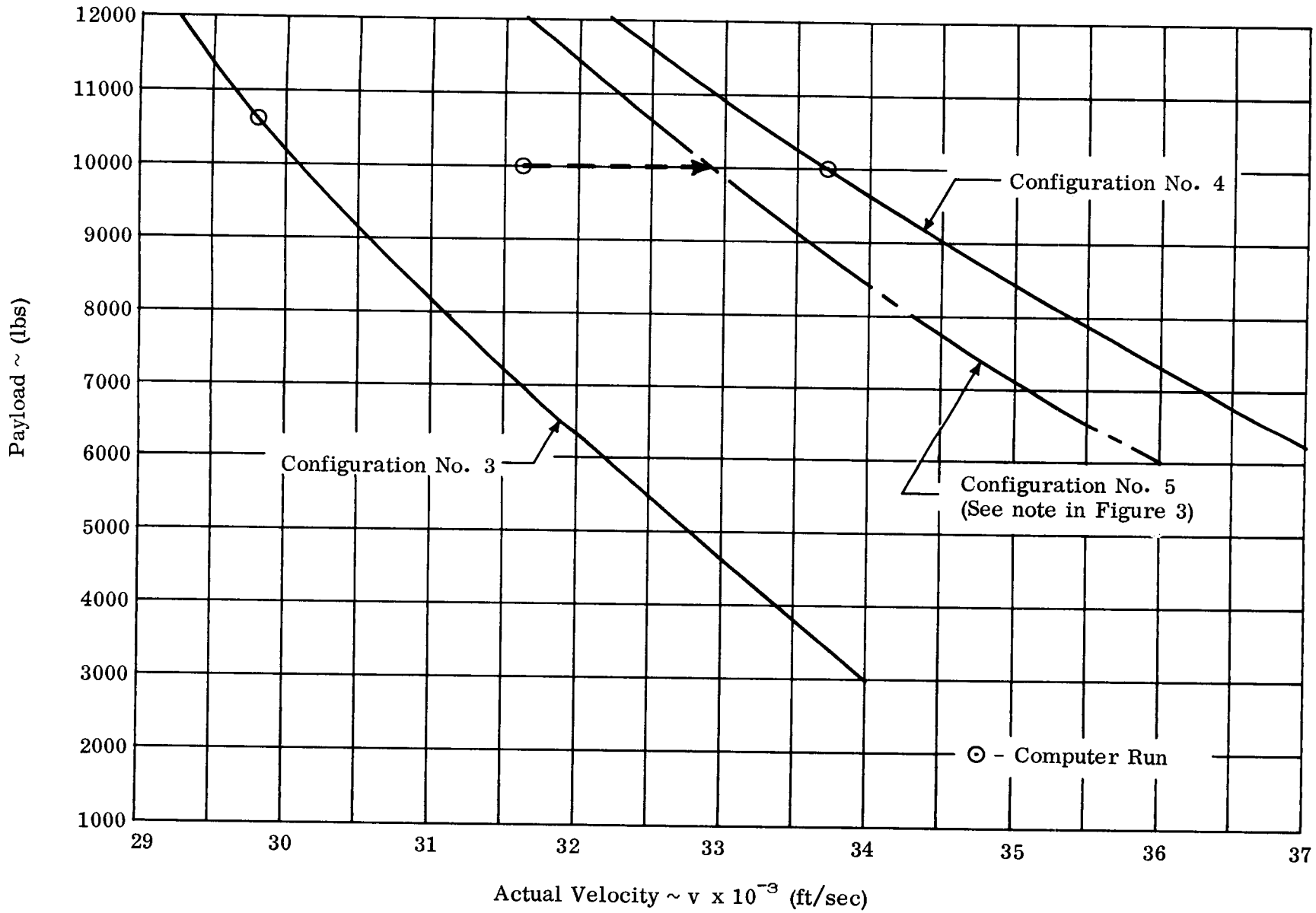

Figure 6. Payload Weight versus Velocity for Configurations No. 3 and No. 4

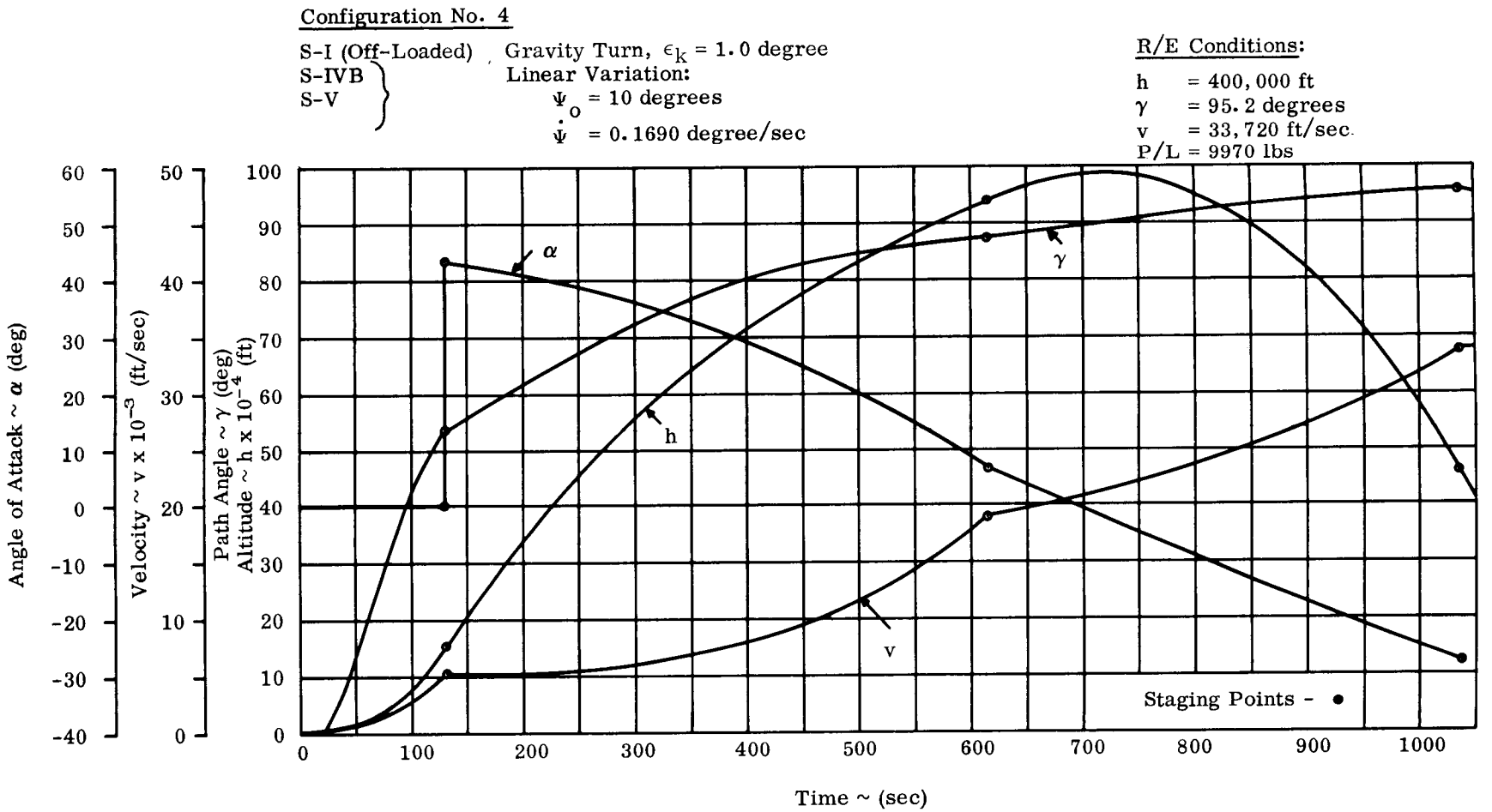

Figure 7. Significant Trajectory Parameters versus Time for Configuration No. 4

Table 6

Summary of Performance Parameters for the Best Trajectory Obtained for Configuration No. 4

Configuration No. 4					
First-Stage Kick Angle = 1.0 degree Second- and Third-Stage Thrust Vector Program Ψ_o = 10 degrees $\dot{\Psi}$ = 0.1690 degree/sec					
R/E Conditions		(Payload Wt. = 9,970 lbs)			
h = 400,000 ft					
γ = 95.2 degrees					
V = 33,720 ft/sec					
S-I Stage					
ΔV_{actual} =	5146 ft/sec	ΔV_{α} =	0 ft/sec	W_p =	776,830 lbs (off-loaded)
$\Delta V_{gravity}$ =	-3656 ft/sec	ΔV_{ideal} =	9094 ft/sec	W_e =	132,337 lbs
ΔV_{drag} =	- 292 ft/sec			Avg. I_{sp} =	272 sec
S-IVB Stage					
ΔV_{actual} =	13,852 ft/sec	ΔV_{α} =	-2,092 ft/sec	W_p =	229,890 lbs
$\Delta V_{gravity}$ =	-3,668 ft/sec	ΔV_{ideal} =	19,612 ft/sec	W_e =	25,943 lbs
ΔV_{drag} =	0 ft/sec			I_{sp} =	422 sec
S-V Stage					
ΔV_{actual} =	14,658 ft/sec	ΔV_{α} =	- 689 ft/sec	W_p =	30,030 lbs
$\Delta V_{gravity}$ =	+ 489 ft/sec	ΔV_{ideal} =	14,858 ft/sec	W_e =	5,000 lbs
ΔV_{drag} =	0 ft/sec			I_{sp} =	420 sec
Coast					
Velocity Increase = 64 ft/sec					
Total: V_{ideal} = 43,564 ft/sec					
V_{actual} = 33,720 ft/sec					
Combined Velocity Loss = 9,844 ft/sec					

CONFIGURATION NO. 5

This configuration is a three-stage vehicle consisting of the S-I first stage, the S-IVB second stage, and a service module which uses high-energy propellants (hydrogen-oxygen) as the third stage. The computer data for this vehicle were generated for a payload of 9972 pounds by assuming that the third stage was fully loaded and both the first and second stages were off-loaded. The best trajectory obtained for this vehicle by using these assumptions is described in Figure 8 and Table 7.

By fully loading the two upper stages and off-loading only the first stage, the vehicle ideal velocity is increased from 39,690 feet per second (Table 7), as run on the computer, to a value of 40,960 feet per second. Using the velocity loss for the computer data, this would then yield an actual velocity of 32,890 feet per second. The variation of actual velocity with payload was calculated by assuming that the two upper stages were fully loaded and that the first stage was off-loaded as shown in Figures 3 and 6.

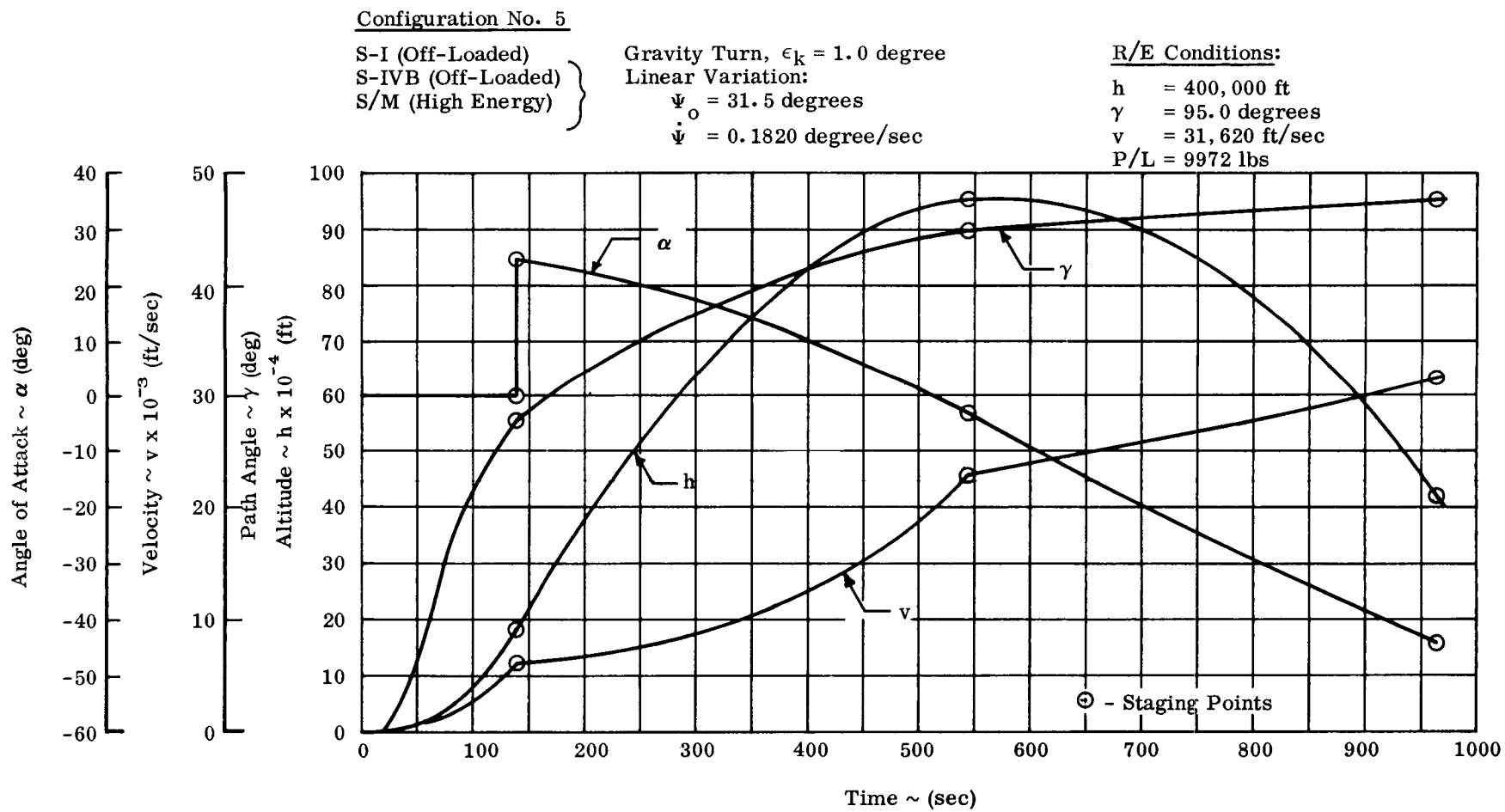

Figure 8. Significant Trajectory Parameters versus Time for Configuration No. 5

Table 7

Summary of Performance Parameters for the Best Trajectory Obtained for Configuration No. 5

Configuration No. 5					
First-Stage Kick Angle = 1.0 degree					
Second- and Third-Stage Thrust Vector Program:					
Ψ_o = 31.5 degrees					
$\dot{\Psi}$ = 0.1820 degree/sec					
R/E Conditions		(Payload Wt. = 9,972 lbs)			
h = 400,000 ft					
γ = 95.0 degrees					
V = 31,620 ft/sec					
S-I Stage					
ΔV_{actual} =	6,060 ft/sec	ΔV_{α} =	0 ft/sec	W_p =	824,270 lbs (off-loaded)
$\Delta V_{gravity}$ =	-3,804 ft/sec	ΔV_{ideal} =	10,157 ft/sec	W_e =	136,930 lbs
ΔV_{drag} =	- 293 ft/sec			Avg. I_{sp} =	273 sec
S-IVB Stage					
ΔV_{actual} =	16,810 ft/sec	ΔV_{α} =	-494 ft/sec	W_p =	192,444 lbs (off-loaded)
$\Delta V_{gravity}$ =	-2,855 ft/sec	ΔV_{ideal} =	20,159 ft/sec	W_e =	26,356 lbs
ΔV_{drag} =	0 ft/sec			I_{sp} =	422 sec
S/M (High Energy)					
ΔV_{actual} =	8,734 ft/sec	ΔV_{α} =	-1,204 ft/sec	W_p =	15,028 lbs
$\Delta V_{gravity}$ =	+ 564 ft/sec	ΔV_{ideal} =	9,374 ft/sec	W_e =	5,000 lbs
ΔV_{drag} =	0 ft/sec			I_{sp} =	419 sec
Coast					
Velocity Increase = 15 ft/sec					
Total: V_{ideal} = 39,690 ft/sec					
V_{actual} = 31,620 ft/sec					
Combined Velocity Loss = 8,070 ft/sec					

RESULTS

For each of the five launch vehicle configurations studied, a representative trajectory was obtained for one payload weight (Figures 1, 2, 4, 5, 7, and 8).

The trajectory attitude program, propellants consumed, stage burnout weights, average stage specific impulse, and a breakdown of the various velocity losses incurred are tabulated for each configuration in Tables 3 through 7.

Table 8 presents in tabular form trajectory parameters at stage burnout conditions for each of the five launch vehicle configurations. Data are presented for the best trajectory obtained for each configuration and also for several other trajectories that also met the specified end-conditions.

It was observed during this study that the trajectories are quite sensitive to some of the attitude program variables. As an example, for a given first-stage kick angle (ϵ_k) there is an allowable variation of about 10 to 20 degrees of the initial thrust vector angle (Ψ_o) in order to intercept the specified end-conditions. It was also found that for a given first-stage kick angle (ϵ_k) and a given initial thrust vector angle (Ψ_o) the rate of change of the thrust vector angle, or pitch rate, ($\dot{\Psi}$) is extremely critical. This is illustrated in Table 9. For the case shown the pitch rate ($\dot{\Psi}$) must be accurate to within approximately ±0.004 degree per second. This could present a practical limitation because of the accuracy of the control system required.

For Configurations No. 1 and No. 2 the effect of coasting between stages was studied. Based on the somewhat limited results (Table 8) it is believed that no appreciable gain in velocity can be achieved by coasting between stages for Configurations No. 1 and No. 2. Coasting data obtained for the other configurations was too limited to permit drawing any conclusions.

Figures 3 and 6 show that even with drastic reductions in payload, Configurations No. 1, No. 2 and No. 3 would not be able to supply the desired velocity of 36,000 feet per second. For Configuration No. 5 the payload would have to be reduced to about 6000 pounds before the desired velocity could be achieved. With Configuration No. 4 a reduction in payload to approximately 7000 pounds would be necessary.

Table 8

	1st Stage Burnout					2nd Stage Burnout					3rd Stage Burnout					Re-entry Conditions at 400,000 feet			
Configuration No. 1	h	R	V	γ	t	h	R	V	γ	t	h	R	V	γ	t	R	V	γ	t
	(ft x 10^{-6})	(n. mi.)	(ft/sec)	(deg)	(sec)	(ft x 10^{-6})	(n. mi)	(ft/sec)	(deg)	(sec)	(ft x 10^{-6})	(n. mi.)	(ft/sec)	(deg)	(sec)	(n. mi.)	(ft/sec)	(deg)	(sec)
G. T. Throughout ϵ_k = 0.55 degree	0.236	18.6	6224	34.4	143.5	1.838	692.0	26,087	80.8	549.5						15,833	27,640	96.0	5,842
G. T. Throughout, 50-sec coast between 1st and 2nd Stage ϵ_k = 0.480	0.241	16.4	6170	30.4	143.5	0.796	751.8	27,385	90.8	599.5						1,322	27,820	95.4	734
*G. T. 1st Stage, ϵ_k = 1.0 degree 2nd Stage, ψ_o = 55 degrees $\dot{\psi}$ = 0.1548 degree/sec	0.196	30.6	6637	56.4	143.5	0.427	929.8	30,068	96.1	549.5						970	30,100	95.8	558
Configuration No. 2																			
G. T. Throughout ϵ_k = 1.180 degrees	0.177	34.4	6813	63.5	143.5	0.686	470.0	27,850	83.6	338.5						18,050	28,160	95.2	6,757
*G. T. 1st Stage, ϵ_k = 1.2 degrees 2nd Stage, ψ_o = 65 degrees $\dot{\psi}$ = 0.2750 degree/sec	0.175	34.7	6832	64.2	143.5	0.430	478.0	27,918	95.5	338.5						525	27,950	95.3	349
G. T. 1st Stage, ϵ_k = 1.0 degree 2nd Stage ψ_o = 75 degrees $\dot{\psi}$ = 0.205 degree/sec	0.196	30.6	6637	56.4	143.5	0.456	457.0	27,540	95.6	338.5						545	27,600	95.4	359
G. T. 1st Stage ϵ_k = 1.2 degrees 50 sec coast 2nd Stage, ψ_o = 55 degrees, $\dot{\psi}$ = 0.328 degree/sec	0.175	34.7	6832	64.2	143.5	0.423	520.0	27,721	95.4	388.5						564	27,700	95.3	398
Configuration No. 3																			
*G. T. 1st Stage, ϵ_k = 1.2 degrees 2nd and 3rd Stages, ψ_o = 30 degrees $\dot{\psi}$ = 0.1598 degree/sec	0.093	11.5	3371	53.7	110.2	0.683	485.0	19,874	83.1	458.4	0.477	2650	29,718	96.3	1034.4	2,758	29,800	95.8	1,058
G. T. 1st Stage, ϵ_k = 1.2 degrees 2nd and 3rd Stages, ψ_o = 20 degrees $\dot{\psi}$ = 0.1780 degree/sec	0.093	11.5	3371	53.7	110.2	0.906	442.0	18,789	78.0	458.4	1.143	2402	27,578	98.2	1034.4	3,390	28,375	95.4	1,258
G. T. 1st Stage, ϵ_k = 1.0 degree 2nd and 3rd Stages, ψ_o = 48 degrees $\dot{\psi}$ = 0.054 degree/sec	0.098	9.9	3285	46.5	110.2	0.714	487.0	19,396	76.9	458.4	3.005	2373	26,469	76.8	1034.4	18,800	29,050	95.6	8,338
Configuration No. 4																			
*G. T. 1st Stage, ϵ_k = 1.0 degree 2nd and 3rd Stages, ψ_o = 10 degrees $\dot{\psi}$ = 0.1690 degree/sec	0.154	20.8	5146	53.4	131.0	0.941	682.0	18,998	87.2	616.0	0.460	2343	33,656	95.9	1036.0	2,445	33,720	95.2	1,055
G. T. 1st Stage, ϵ_k = 0.40 degree 2nd and 3rd Stages, ψ_o = 30 degrees $\dot{\psi}$ = 0.0684 degree/sec	0.185	9.3	4753	24.0	131.0	1.621	517.0	16,287	73.1	616.0	3.912	1738	27,855	71.9	1036.0	18,546	31,040	96.4	13,071
G. T. 1st Stage, ϵ_k = 0.60 degree 2nd and 3rd Stages, ψ_o = 35 degrees $\dot{\psi}$ = 0.06273 degree/sec	0.176	13.5	4863	34.9	131.0	1.344	615.0	17,510	76.5	616.0	3.557	1940	29,088	71.5	1036.0	19,170	31,890	96.6	16,752
G. T. 1st Stage, ϵ_k = 0.80 degree 2nd and 3rd Stages, ψ_o = 40 degrees $\dot{\psi}$ = 0.0586 degree/sec	0.166	17.4	4998	44.7	131.0	0.998	709.0	18,772	80.2	616.0	3.012	2159	30,448	71.9	1036.0	19,814	32,730	96.9	22,612
Configuration No. 5																			
*G. T. 1st Stage, ϵ_k = 1.0 degree 2nd and 3rd Stages, ψ_o = 31.5 degrees $\dot{\psi}$ = 0.182 degree/sec	0.179	26.7	6060	55.4	139.0	0.950	739.0	22,871	89.6	545.0	0.418	2528	31,605	95.2	965.0	2,560	31,620	95.0	972
G. T. 1st Stage, ϵ_k = 0.40 degree 2nd and 3rd Stages, ψ_o = 20 degrees $\dot{\psi}$ = 0.197 degree/sec	0.222	12.1	5586	25.1	139.0	1.834	499.0	19,288	82.6	545.0	1.600	1934	27,137	99.4	965.0	3,365	28,400	95.4	1,297

* Designates the best trajectory obtained for each of the five launch vehicle configurations.

G. T. = Gravity Turn

Tabulation of the Stage Burnout and Re-entry Conditions for Some Typical Trajectories Obtained for Each of the Launch Vehicle Configurations Studied

Table 9

Typical Set of Data Illustrating Sensitivity of Re-entry Point to Thrust Vector Pitch Rate

Configuration No. 3

$\dot{\Psi}$ (degree/sec)	2nd Stage Burnout			3rd Stage Burnout			R/E Conditions		
	h (ft)	V (ft/sec)	γ (deg)	h (ft)	V (ft/sec)	γ (deg)	h (ft)	V (ft/sec)	γ (deg)
0.084	1,049,349	17,851	67.5	4,119,724	24,219	76.8	400,000	27,980	98.113
0.086	1,040,763	17,909	67.9	4,039,635	24,396	77.4	400,000	28,070	96.725
*0.0878	1,032,981	17,960	68.3	3,966,692	21,500	77.9	400,000	28,150	95.293
0.088	1,032,113	17,966	68.4	3,958,537	24,571	77.97	400,000	28,153	95.143
0.090	1,023,400	18,023	68.8	3,876,441	24,744	78.5		Orbits	
0.1500	734,831	19,633	81.1	1,007,268	29,143	93.99		Orbits	
0.1550	708,639	19,758	82.1	738,321	29,442	95.2		Orbits	
*0.1598	683,222	19,874	83.1	476,698	29,720	96.3	400,000	29,800	95.8
0.1600	682,157	19,880	83.1	465,727	29,731	96.4	400,000	29,800	95.98
**0.1650	655,392	20,000	84.1	189,690	30,011	97.6	189,690	30,011	97.6

First-Stage Gravity Turn, ϵ_k = 1.2 degrees

First-Stage Burnout Conditions

h = 93,346 ft.

V = 3,371 ft/sec

γ = 53.678 degrees

Second- and Third-Stage Linear Attitude Program

Ψ_o = 30 degrees

* Intercepts the specified re-entry point.

** Re-enters before third-stage burnout.

ADDITIONAL CONSIDERATIONS

Other factors that can have a significant influence on the results are the following:

1. Propellant reserves.
2. Interrupted burning with coast during second (or third) stage operation.
3. Increased thrust/weight ratio of upper stage.
4. Reduction of launch thrust/weight ratio below 1.25.
5. Consolidation of certain fixed weights, such as batteries, from the upper stage into the C/M.
6. Downrange position of re-entry, and impact points.

While none of these factors was evaluated in the detailed calculations of this study, some thoughts have emerged which appear worthy of note.

Propellant reserves were not considered specifically. Increase of reserves for these special tests would result in performance penalties, particularly in the upper stages, where there is a one-pound decrease in payload for every pound of residual propellant in the reserves.

Value of coasting during, rather than between, stage operations may have possible beneficial results. A coast at the right time permits time for gravity to turn the flight path downward, with subsequent firings with thrust directed downward.

Increased thrust/weight ratio of the upper stage may be beneficial, also, for essentially the same reason. The higher thrust minimizes burn time, facilitating a longer coast and downward acceleration during burning.

Reduction of launch thrust/weight ratio would represent substantial performance gains. With a more completely filled first stage, velocity could possibly be increased as much as 1000 feet per second. However, disadvantages of the lower thrust/weight ratio are well known, and may preclude such a possibility.

Repositioning of weight, such as batteries, guidance, and controls, from the third stage to the C/M provides obvious advantages. For the same upper-stage burnout weight, the C/M weight is increased one pound for every pound transferred from the upper stage.

While not considered during this study, it may become appropriate to consider the position of the down-range re-entry and impact points. Constraint because of the location of these points for tracking and observation, may prove to be the controlling factor for trajectory selection.

REFERENCES

1. Two-Dimensional Satellite Insertion Program, Program No. 2368, Advanced Guidance Unit, Defense Systems Department, General Electric Company.

2. Two-Dimensional Ballistic Missile Design and Trajectory Program, Program No. 2356, Advanced Guidance Unit, Defense Systems Department, General Electric Company.

APPENDIX A

SAMPLE DIGITAL PRINTOUT FOR LAUNCH VEHICLE CONFIGURATION NO. 4

For reference purposes, a complete set of the digital data for launch vehicle Configuration No. 4 is included in this section. The data are annotated and are self-explanatory, except for the method of calculating thrust. The following equation is used by the computer:

$$F = P_c A_t \left[C_{f_{vac}} - \epsilon \frac{P_a}{P_c} \right]$$

which can be rewritten as

$$F = P_c A_t C_{f_{vac}} - \epsilon A_t P_a$$

to calculate thrust. Suitable values for the parameters P_c and $C_{f_{vac}}$, as shown on the first page of the computer printout, were assumed in order to facilitate the use of the existing computer program.

TWO DIMENSIONAL SATELLITE INSERTION PROGRAM
PN 23685 - SINGLE PRECISION

IDENTIFICATION NUMBER- C4K1.0
DATE-07-25-62

NUMBER OF STAGES- 3
KICK ANGLE= 1.000 DEGREES
KICK AT TIME= 20.00 SECONDS
INTEGRATION STEP SIZE= 1.000 SECONDS
NO HANDOFF TO INERTIAL CONTROL
THRUST ATTITUDE CONTROL PROGRAM(S) ENTERED
MACH NO. VS. DRAG COEFFICIENT TABLE ENTERED

MISSILE STAGE CHARACTERISTICS

STAGE	CHAMBER PRESSURE	THROAT AREA	THRUST COEFF.	EXPANSION RATIO	INITIAL WEIGHT	BURNING RATE	STEP SIZE	DIAMETER	BURNOUT
1	1.000	1515.000	1115.000	8.100	1210000.	5930.00	0. SEC	260.00	131.00 SEC
2	200000.000	1.000	1.000	0.	300833.	474.00	10.00 SEC	0.	485.00 SEC
3	30000.000	1.000	1.000	0.	45000.	71.50	0. SEC	0.	420.00 SEC
PAYLOAD					10000.				

MACH NUMBER VS. DRAG COEFFICIENT TABLE

10 ENTRIES IN TABLE

MACH NUMBERS	0.	0.560	1.000	1.222	2.000	3.000	4.000	5.000	6.000	7.000
DRAG COEFFS.	1.0000	0.2900	0.7100	0.7300	0.4700	0.3000	0.2100	0.1700	0.1300	0.1100

THRUST ATTITUDE CONTROL PROGRAM(S)

TIME SINCE LAUNCH	TYPE	PSI-ZERO	PSI-DOT	PSI-DDOT
131.00	PARABOLIC	10.00000	0.169000	0.

INPUT-OUTPUT UNITS

TIME-SECONDS	WEIGHT-POUNDS	THRUST-POUNDS	DRAG-POUNDS
VELOCITY-FEET PER SECOND	ANGLES-DEGREES	ALTITUDE-FEET	EARTH RANGE-NAUTICAL MILES
(TAN.)ACCELERATION-G	SPECIFIC IMPULSE(ISP)-SECONDS		DYNAMIC PRESSURE(Q)-POUNDS/SQUARE FOOT
(SLANT)RANGE-FEET	(SLANT)RANGE RATE-FEET PER SECOND		ELEVATION ANGLE RATE-DEGREES PER SECOND
NRML ACCELERATION-G	AR-RESULTANT ACCELERATION-G		ACCELEROMETER VELOCITY-FEET PER SECOND

BEGIN STAGE 1
INTEGRATION STEP SIZE= 1.000
TIME CUTOFF AT 131.00 SEC

TIME	ALTITUDE	THRUST	ISP	VELOCITY	ACCLRMTR VELOCITY	GAMMA	PSI	ALPHA	WEIGHT	EARTH RANGE	RANGE ANGLE
DYNAMIC PRESSURE		DRAG	ACC	RANGE	RANGE RATE	ELEVATION	E RATE	NORML ACC	AR	LOOK ANGLE	
0.	0.	1508883.	254.45	0.	0.	0.	0.	0.	1210000.0	0.	0.
0.	0.		0.25	0.	0.	90.000	0.	0.	0.	0.	
1.00	4.0065200E 00	1508910.	254.45	8.05	0.	0.	0.	0.	1204070.0	0.	0.
7.6928715E-02	2.8104493E 01		0.25	4.0065200E 00	8.05	90.000	0.	0.	0.	0.	
2.00	1.6158098E 01	1508989.	254.47	16.29	0.	0.	0.	0.	1198140.0	0.	0.
3.1524042E-01	1.1407891E 02		0.26	1.6158098E 01	16.29	90.000	0.	0.	0.	0.	
3.00	3.6654140E 01	1509123.	254.49	24.74	0.	0.	0.	0.	1192210.0	0.	0.
7.2635279E-01	2.6028273E 02		0.27	3.6654140E 01	24.74	90.000	0.	0.	0.	0.	
4.00	6.5695903E 01	1509312.	254.52	33.38	0.	0.	0.	0.	1186280.0	0.	0.
1.3218320E 00	4.6887947E 02		0.27	6.5695903E 01	33.38	90.000	0.	0.	0.	0.	
5.00	1.0348650E 02	1509558.	254.56	42.23	0.	0.	0.	0.	1180350.0	0.	0.
2.1133609E 00	7.4181097E 02		0.28	1.0348650E 02	42.23	90.000	0.	0.	0.	0.	
6.00	1.5023089E 02	1509861.	254.61	51.29	0.	0.	0.	0.	1174420.0	0.	0.
3.1127046E 00	1.0807711E 03		0.28	1.5023089E 02	51.29	90.000	0.	0.	0.	0.	
7.00	2.0613592E 02	1510224.	254.68	60.55	0.	0.	0.	0.	1168490.0	0.	0.
4.3316755E 00	1.4871794E 03		0.29	2.0613592E 02	60.55	90.000	0.	0.	0.	0.	
8.00	2.7141033E 02	1510646.	254.75	70.03	0.	0.	0.	0.	1162560.0	0.	0.
5.7820956E 00	1.9621541E 03		0.30	2.7141033E 02	70.03	90.000	0.	0.	0.	0.	
9.00	3.4626478E 02	1511130.	254.83	79.72	0.	0.	0.	0.	1156630.0	0.	0.
7.4757565E 00	2.5064851E 03		0.30	3.4626478E 02	79.72	90.000	0.	0.	0.	0.	
10.00	4.3091186E 02	1511676.	254.92	89.61	0.	0.	0.	0.	1150700.0	0.	0.
9.4243807E 00	3.1206075E 03		0.31	4.3091186E 02	89.61	90.000	0.	0.	0.	0.	
11.00	5.2556621E 02	1512285.	255.02	99.73	0.	0.	0.	0.	1144770.0	0.	0.
1.1639578E 01	3.8045740E 03		0.32	5.2556621E 02	99.73	90.000	0.	0.	0.	0.	
12.00	6.3044450E 02	1512957.	255.14	110.06	0.	0.	0.	0.	1138840.0	0.	0.
1.4132805E 01	4.5580291E 03		0.32	6.3044450E 02	110.06	90.000	0.	0.	0.	0.	
13.00	7.4576553E 02	1513694.	255.26	120.62	0.	0.	0.	0.	1132910.0	0.	0.
1.6915319E 01	5.3801824E 03		0.33	7.4576553E 02	120.62	90.000	0.	0.	0.	0.	
14.00	8.7175028E 02	1514497.	255.40	131.39	0.	0.	0.	0.	1126980.0	0.	0.
1.9998137E 01	6.2697837E 03		0.34	8.7175028E 02	131.39	90.000	0.	0.	0.	0.	
15.00	1.0086221E 03	1515365.	255.54	142.39	0.	0.	0.	0.	1121050.0	0.	0.
2.3391986E 01	7.2250967E 03		0.35	1.0086221E 03	142.39	90.000	0.	0.	0.	0.	

TIME	ALTITUDE	THRUST	ISP	VELOCITY	ACCLRMTR VELOCITY	GAMMA	PSI	ALPHA	WEIGHT	EARTH RANGE	RANGE ANGLE
DYNAMIC PRESSURE		DRAG	ACC	RANGE	RANGE RATE	ELEVATION	E RATE	NORML ACC	AR	LOOK ANGLE	
16.00	1.1566066E 03	1516300.	255.70	153.62	0.	0.	0.	0.	1115120.0	0.	0.
2.7107266E 01	8.2438757E 03	0.35	1.1566066E 03	153.62	90.000	0.	0.	0.	0.		
17.00	1.3159322E 03	1517302.	255.87	165.07	0.	0.	0.	0.	1109190.0	0.	0.
3.1153997E 01	9.3233423E 03	0.36	1.3159322E 03	165.07	90.000	0.	0.	0.	0.		
18.00	1.4868295E 03	1518372.	256.05	176.76	0.	0.	0.	0.	1103260.0	0.	0.
3.5541783E 01	1.0460161E 04	0.37	1.4868295E 03	176.76	90.000	0.	0.	0.	0.		
19.00	1.6695325E 03	1519510.	256.24	188.68	0.	0.	0.	0.	1097330.0	0.	0.
4.0279759E 01	1.1650420E 04	0.37	1.6695325E 03	188.68	90.000	0.	0.	0.	0.		
20.00	1.8642776E 03	1520716.	256.44	200.85	0.	0.	0.	0.	1091400.0	0.	0.
4.5376558E 01	1.2889608E 04	0.38	1.8642776E 03	200.85	90.000	0.	0.	0.	0.		

KICK OVER ANGLE= 1.0000 DEGREES

21.00	2.0712705E 03	1521991.	256.66	213.25	0.	1.168	1.168	0.	1085470.0	0.00	0.000
5.0843050E 01	1.4173252E 04	0.39	2.0712742E 03	213.23	89.892	-0.109	0.020	0.39	1.060		
22.00	2.2907794E 03	1523334.	256.89	225.91	0.	1.352	1.352	0.	1079540.0	0.00	0.000
5.6685250E 01	1.5495184E 04	0.40	2.2907960E 03	225.86	89.781	-0.112	0.024	0.40	1.134		
23.00	2.5230478E 03	1524746.	257.12	238.82	0.	1.553	1.553	0.	1073610.0	0.00	0.000
6.2910458E 01	1.6849045E 04	0.41	2.5230902E 03	238.79	89.668	-0.116	0.027	0.41	1.221		
24.00	2.7683223E 03	1526226.	257.37	251.98	0.	1.771	1.771	0.	1067680.0	0.00	0.000
6.9525411E 01	1.8227812E 04	0.41	2.7684077E 03	251.90	89.550	-0.120	0.031	0.41	1.321		
25.00	3.0268527E 03	1527774.	257.63	265.40	0.	2.005	2.005	0.	1061750.0	0.00	0.000
7.6536268E 01	1.9623782E 04	0.42	3.0270040E 03	265.32	89.427	-0.126	0.035	0.42	1.432		
26.00	3.2988919E 03	1529390.	257.91	279.10	0.	2.257	2.257	0.	1055820.0	0.01	0.000
8.3948591E 01	2.1028548E 04	0.43	3.2991391E 03	278.98	89.298	-0.132	0.039	0.43	1.555		
27.00	3.5846962E 03	1531074.	258.19	293.06	0.	2.525	2.525	0.	1049890.0	0.01	0.000
9.1767330E 01	2.2432986E 04	0.44	3.5850780E 03	292.93	89.164	-0.138	0.044	0.44	1.689		
28.00	3.8845254E 03	1532825.	258.49	307.30	0.	2.811	2.811	0.	1043960.0	0.01	0.000
9.9996816E 01	2.3827239E 04	0.45	3.8850910E 03	307.13	89.022	-0.145	0.049	0.45	1.833		
29.00	4.1986430E 03	1534641.	258.79	321.83	0.	3.113	3.114	0.	1038030.0	0.01	0.000
1.0864205E 02	2.5200991E 04	0.46	4.1994542E 03	321.60	88.874	-0.152	0.054	0.46	1.987		
30.00	4.5273163E 03	1536518.	259.11	336.65	0.	3.433	3.433	0.	1032100.0	0.02	0.000
1.1770760E 02	2.6543168E 04	0.47	4.5284502E 03	336.41	88.718	-0.160	0.060	0.47	2.150		
31.00	4.8708164E 03	1538462.	259.44	351.77	0.	3.769	3.769	0.	1026170.0	0.02	0.000
1.2719302E 02	2.7840898E 04	0.47	4.8723679E 03	351.45	88.554	-0.168	0.066	0.48	2.323		

TIME	ALTITUDE	THRUST	ISP	VELOCITY	ACCLRMTR VELOCITY	GAMMA	PSI	ALPHA	WEIGHT	EARTH RANGE	RANGE ANGLE
	DYNAMIC PRESSURE	DRAG	ACC	RANGE	RANGE	RATE	ELEVATION	E RATE	NORML ACC	AR	LOOK ANGLE
32.00	5.2294188E 03	1540469.	259.78	367.20	0.	4.121	4.121	0.	1020240.0	0.02	0.000
	1.3709986E 02	2.9081118E 04	0.48	5.2315033E 03		366.83	88.382	-0.176	0.072	0.49	2.504
33.00	5.6034030E 03	1542540.	260.12	382.94	0.	4.490	4.490	0.	1014310.0	0.03	0.000
	1.4742900E 02	3.0249905E 04	0.49	5.6061609E 03		382.52	88.202	-0.184	0.078	0.50	2.692
34.00	5.9930538E 03	1544674.	260.48	399.02	0.	4.874	4.875	0.	1008380.0	0.03	0.001
	1.5818057E 02	3.1332453E 04	0.50	5.9966528E 03		398.51	88.014	-0.192	0.085	0.51	2.889
35.00	6.3986605E 03	1546869.	260.85	415.44	0.	5.274	5.274	0.	1002450.0	0.04	0.001
	1.6935398E 02	3.2313038E 04	0.52	6.4033012E 03		414.82	87.818	-0.201	0.092	0.52	3.093
36.00	6.8205179E 03	1549123.	261.23	432.21	0.	5.689	5.690	0.	996520.0	0.05	0.001
	1.8094792E 02	3.3174987E 04	0.53	6.8264372E 03		431.49	87.613	-0.209	0.099	0.54	3.303
37.00	7.2589262E 03	1551435.	261.62	449.35	0.	6.118	6.119	0.	990590.0	0.05	0.001
	1.9296036E 02	3.3900641E 04	0.54	7.2664030E 03		448.49	87.400	-0.217	0.106	0.55	3.519
38.00	7.7141917E 03	1553804.	262.02	466.86	0.	6.562	6.563	0.	984660.0	0.06	0.001
	2.0538850E 02	3.4471317E 04	0.55	7.7235520E 03		465.84	87.178	-0.226	0.114	0.56	3.742
39.00	8.1866269E 03	1556226.	262.43	484.76	0.	7.020	7.021	0.	978730.0	0.07	0.001
	2.1822881E 02	3.4867266E 04	0.56	8.1982496E 03		483.59	86.948	-0.235	0.122	0.58	3.969
40.00	8.6765511E 03	1558695.	262.85	503.07	0.	7.491	7.492	0.	972800.0	0.08	0.001
	2.3148783E 02	3.5069280E 04	0.58	8.6908743E 03		501.72	86.709	-0.243	0.130	0.59	4.201
41.00	9.1842906E 03	1561216.	263.27	521.80	0.	7.974	7.975	0.	966870.0	0.09	0.002
	2.4514829E 02	3.5053329E 04	0.59	9.2018188E 03		520.23	86.462	-0.251	0.139	0.61	4.438
42.00	9.7101794E 03	1563786.	263.71	540.98	0.	8.469	8.471	0.	960940.0	0.11	0.002
	2.5920343E 02	3.4796075E 04	0.60	9.7314900E 03		539.16	86.206	-0.260	0.147	0.62	4.677
43.00	1.0254560E 04	1566404.	264.15	560.61	0.	8.976	8.978	0.	955010.0	0.12	0.002
	2.7364565E 02	3.4272935E 04	0.62	1.0280312E 04		558.53	85.943	-0.268	0.156	0.64	4.921
44.00	1.0817785E 04	1569066.	264.60	580.72	0.	9.494	9.496	0.	949080.0	0.13	0.002
	2.8846639E 02	3.3458012E 04	0.63	1.0848725E 04		578.35	85.671	-0.276	0.165	0.65	5.166
45.00	1.1400215E 04	1571770.	265.05	601.33	0.	10.021	10.024	0.	943150.0	0.15	0.003
	3.0365484E 02	3.2545954E 04	0.65	1.1437189E 04		598.64	85.390	-0.284	0.174	0.67	5.414
46.00	1.2002190E 04	1574513.	265.52	622.37	0.	10.559	10.561	0.	937220.0	0.17	0.003
	3.1911106E 02	3.6000236E 04	0.66	1.2046150E 04		619.31	85.102	-0.292	0.183	0.68	5.663
47.00	1.2623948E 04	1577288.	265.98	643.77	0.	11.105	11.108	0.	931290.0	0.19	0.003
	3.3473374E 02	3.9880260E 04	0.67	1.2675962E 04		640.33	84.806	-0.300	0.192	0.70	5.914
48.00	1.3265691E 04	1580093.	266.46	665.53	0.	11.660	11.663	0.	925360.0	0.21	0.003
	3.5046749E 02	4.4205746E 04	0.68	1.3326948E 04		661.67	84.502	-0.307	0.202	0.71	6.165

[redacted]

TIME	ALTITUDE	THRUST	ISP	VELOCITY	ACCLRMTR VELOCITY	GAMMA	PSI	ALPHA	WEIGHT	EARTH RANGE	RANGE ANGLE
	DYNAMIC PRESSURE	DRAG	ACC	RANGE	RANGE	RATE	ELEVATION	E RATE	NORML ACC	AR	LOOK ANGLE
49.00	1.3927599E 04	1582928.	266.94	687.63	0.	12.222	12.226	0.	919430.0	0.23	0.004
	3.6624598E 02	4.8989519E 04	0.69	1.3999424E 04		683.33	84.192	-0.315	0.211	0.72	6.417
50.00	1.4609836E 04	1585789.	267.42	710.08	0.	12.792	12.796	0.	913500.0	0.26	0.034
	3.8201119E 02	5.4238564E 04	0.70	1.4693696E 04		705.26	83.873	-0.322	0.221	0.74	6.670
51.00	1.5312547E 04	1588671.	267.90	732.85	0.	13.369	13.374	0.	907570.0	0.28	0.005
	3.9770288E 02	5.9951528E 04	0.71	1.5410062E 04		727.51	83.548	-0.328	0.231	0.75	6.922
52.00	1.6035857E 04	1591571.	268.39	755.95	0.	13.953	13.958	0.	901640.0	0.31	0.005
	4.1325935E 02	6.6117514E 04	0.72	1.6148808E 04		750.02	83.217	-0.335	0.241	0.76	7.175
53.00	1.6779869E 04	1594478.	268.88	779.36	0.	14.542	14.548	0.	895710.0	0.34	0.006
	4.2863696E 02	7.2718148E 04	0.73	1.6910213E 04		772.82	82.879	-0.341	0.250	0.77	7.426
54.00	1.7544671E 04	1597392.	269.37	803.08	0.	15.137	15.144	0.	889780.0	0.38	0.006
	4.4376363E 02	7.9718908E 04	0.74	1.7694546E 04		795.88	82.534	-0.347	0.260	0.79	7.678
55.00	1.8330327E 04	1600312.	269.87	827.11	0.	15.738	15.745	0.	883850.0	0.41	0.007
	4.5855699E 02	8.7070215E 04	0.75	1.8502067E 04		819.20	82.184	-0.353	0.270	0.80	7.928
56.00	1.9136887E 04	1603232.	270.36	851.43	0.	16.343	16.350	0.	877920.0	0.45	0.008
	4.7295552E 02	9.4712026E 04	0.76	1.9333030E 04		842.76	81.828	-0.359	0.281	0.81	8.178
57.00	1.9964383E 04	1606148.	270.85	876.04	0.	16.952	16.961	0.	871990.0	0.49	0.008
	4.8690118E 02	1.0257024E 05	0.77	2.0187683E 04		866.58	81.466	-0.364	0.291	0.82	8.427
58.00	2.0812837E 04	1609052.	271.34	900.95	0.	17.566	17.575	0.	866060.0	0.54	0.009
	5.0036041E 02	1.1056060E 05	0.78	2.1066275E 04		890.64	81.099	-0.370	0.301	0.83	8.674
59.00	2.1682256E 04	1611939.	271.83	926.15	0.	18.183	18.193	0.	860130.0	0.58	0.010
	5.1328390E 02	1.1857961E 05	0.79	2.1969050E 04		914.95	80.727	-0.375	0.311	0.85	8.920
60.00	2.2572642E 04	1614810.	272.31	951.66	0.	18.804	18.815	0.	854200.0	0.63	0.011
	5.2559019E 02	1.2649898E 05	0.80	2.2896262E 04		939.52	80.350	-0.379	0.321	0.86	9.165
61.00	2.3483995E 04	1617661.	272.79	977.49	0.	19.428	19.439	0.	848270.0	0.68	0.011
	5.3724138E 02	1.3418174E 05	0.81	2.3848170E 04		964.34	79.968	-0.384	0.331	0.87	9.407
62.00	2.4416315E 04	1620487.	273.27	1003.66	0.	20.054	20.066	0.	842340.0	0.74	0.012
	5.4820840E 02	1.4147400E 05	0.82	2.4825047E 04		989.46	79.582	-0.388	0.342	0.89	9.649
63.00	2.5369610E 04	1623274.	273.74	1030.19	0.	20.682	20.696	0.	836410.0	0.80	0.013
	5.5854452E 02	1.4717614E 05	0.83	2.5827189E 04		1014.87	79.192	-0.392	0.352	0.90	9.888
64.00	2.6343937E 04	1626030.	274.20	1057.18	0.	21.313	21.327	0.	830480.0	0.86	0.014
	5.6821892E 02	1.5133907E 05	0.85	2.6854954E 04		1040.72	78.797	-0.396	0.362	0.92	10.124
65.00	2.7339404E 04	1628752.	274.66	1084.66	0.	21.945	21.960	0.	824550.0	0.92	0.015
	5.7719952E 02	1.5495695E 05	0.86	2.7908766E 04		1066.98	78.399	-0.400	0.372	0.94	10.359

[redacted]

TIME	ALTITUDE	THRUST	ISP	VELOCITY	ACCLRMTR VELOCITY	GAMMA	PSI	ALPHA	WEIGHT	EARTH	RANGE
DYNAMIC	PRESSURE	DRAG	ACC	RANGE	RANGE	RATE	ELEVATION	E RATE	NORML ACC	RANGE	ANGLE
										AR	LOOK ANGLE
66.00	2.8356131E 04	1631436.	275.12	1112.67	0.	22.577	22.594	0.	818620.0	0.99	0.017
	5.8546689E 02	1.5798987E 05	0.88	2.8989078E 04	1093.72	77.997	-0.404	0.382	0.96	10.591	
67.00	2.9394253E 04	1634063.	275.56	1141.24	0.	23.211	23.228	0.	812690.0	1.06	0.018
	5.9316438E 02	1.6044468E 05	0.90	3.0096372E 04	1120.96	77.591	-0.408	0.392	0.98	10.819	
68.00	3.0453922E 04	1636649.	275.99	1170.39	0.	23.844	23.863	0.	806760.0	1.14	0.019
	6.0008445E 02	1.6223680E 05	0.92	3.1231160E 04	1148.71	77.181	-0.411	0.402	1.00	11.044	
69.00	3.1535303E 04	1639198.	276.42	1200.17	0.	24.478	24.498	0.	800830.0	1.22	0.020
	6.0610487E 02	1.6330874E 05	0.94	3.2393988E 04	1177.04	76.768	-0.415	0.412	1.02	11.266	
70.00	3.2638585E 04	1641707.	276.85	1230.60	0.	25.111	25.132	0.	794900.0	1.30	0.022
	6.1118454E 02	1.6407079E 05	0.96	3.3585439E 04	1205.95	76.352	-0.418	0.422	1.05	11.484	
71.00	3.3763960E 04	1644089.	277.25	1261.70	0.	25.742	25.765	0.	788970.0	1.39	0.023
	6.1639198E 02	1.6458954E 05	0.98	3.4806118E 04	1235.49	75.932	-0.421	0.432	1.07	11.697	
72.00	3.4911629E 04	1646479.	277.65	1293.51	0.	26.372	26.397	0.	783040.0	1.48	0.025
	6.1991625E 02	1.6425908E 05	1.00	3.6056650E 04	1265.66	75.510	-0.424	0.442	1.09	11.907	
73.00	3.6081813E 04	1648889.	278.06	1326.07	0.	27.001	27.027	0.	777110.0	1.58	0.026
	6.2134758E 02	1.6295903E 05	1.02	3.7337703E 04	1296.55	75.084	-0.427	0.451	1.12	12.111	
74.00	3.7274764E 04	1650988.	278.41	1359.42	0.	27.627	27.655	0.	771180.0	1.68	0.028
	6.1934494E 02	1.6072038E 05	1.05	3.8649994E 04	1328.16	74.656	-0.430	0.461	1.15	12.311	
75.00	3.8490765E 04	1653164.	278.78	1393.63	0.	28.250	28.280	0.	765250.0	1.78	0.030
	6.1386785E 02	1.5734180E 05	1.08	3.9994289E 04	1360.57	74.225	-0.432	0.470	1.18	12.505	
76.00	3.9730130E 04	1655263.	279.13	1428.73	0.	28.871	28.902	0.	759320.0	1.90	0.032
	6.0762276E 02	1.5352083E 05	1.11	4.1371407E 04	1393.81	73.791	-0.435	0.480	1.20	12.693	
77.00	4.0993190E 04	1657279.	279.47	1464.76	0.	29.488	29.521	0.	753390.0	2.01	0.034
	6.0075355E 02	1.4930754E 05	1.13	4.2782204E 04	1427.92	73.355	-0.437	0.489	1.24	12.876	
78.00	4.2280283E 04	1659176.	279.79	1501.74	0.	30.101	30.136	0.	747460.0	2.13	0.036
	5.9396704E 02	1.4489090E 05	1.16	4.4227561E 04	1462.93	72.917	-0.439	0.498	1.27	13.053	
79.00	4.3591751E 04	1661006.	280.10	1539.69	0.	30.710	30.747	0.	741530.0	2.26	0.038
	5.8634341E 02	1.4006055E 05	1.19	4.5708383E 04	1498.86	72.476	-0.442	0.507	1.30	13.224	
80.00	4.4927946E 04	1662763.	280.40	1578.64	0.	31.314	31.354	0.	735600.0	2.39	0.040
	5.7800071E 02	1.3487001E 05	1.23	4.7225603E 04	1535.73	72.034	-0.443	0.516	1.33	13.388	
81.00	4.6289230E 04	1664423.	280.68	1618.61	0.	31.914	31.956	0.	729670.0	2.53	0.042
	5.6952655E 02	1.2948169E 05	1.26	4.8780185E 04	1573.58	71.589	-0.445	0.524	1.36	13.545	
82.00	4.7675969E 04	1666016.	280.95	1659.63	0.	32.508	32.553	0.	723740.0	2.67	0.045
	5.6029716E 02	1.2377954E 05	1.29	5.0373114E 04	1612.42	71.143	-0.447	0.533	1.40	13.696	

TIME	ALTITUDE	THRUST	ISP	VELOCITY	ACCLRMTR VELOCITY	GAMMA	PSI	ALPHA	WEIGHT	EARTH RANGE	RANGE ANGLE
DYNAMIC PRESSURE		DRAG	ACC	RANGE	RANGE	RATE	ELEVATION	E RATE	NORML ACC	AR LOOK	ANGLE
83.00	4.9088537E 04	1667541.	281.20	1701.72	0.	33.097	33.144	0.	717810.0	2.82	0.047
5.5038412E 02	1.1781603E 05		1.33	5.2005405E 04	1652.32	70.696	-0.448	0.541	1.43	13.840	
84.00	5.0527314E 04	1668975.	281.45	1744.91	0.	33.681	33.730	0.	711880.0	2.98	0.050
5.4040132E 02	1.1175856E 05		1.36	5.3678098E 04	1693.24	70.247	-0.450	0.549	1.47	13.977	
85.00	5.1992683E 04	1670347.	281.68	1789.20	0.	34.258	34.310	0.	705950.0	3.14	0.052
5.2967713E 02	1.0550395E 05		1.39	5.5392253E 04	1735.25	69.796	-0.451	0.557	1.50	14.106	
86.00	5.3485032E 04	1671651.	281.90	1834.63	0.	34.829	34.884	0.	700020.0	3.31	0.055
5.1843952E 02	9.9144968E 04		1.43	5.7148957E 04	1778.35	69.344	-0.452	0.565	1.54	14.229	
87.00	5.5004749E 04	1672878.	282.10	1881.20	0.	35.394	35.452	0.	694090.0	3.48	0.058
5.0705692E 02	9.2796993E 04		1.47	5.8949314E 04	1822.54	68.892	-0.453	0.573	1.57	14.344	
88.00	5.6552226E 04	1674047.	282.30	1928.94	0.	35.952	36.014	0.	688160.0	3.66	0.061
4.9499036E 02	8.6407509E 04		1.50	6.0794448E 04	1867.90	68.438	-0.454	0.581	1.61	14.452	
89.00	5.8127842E 04	1675147.	282.49	1977.82	0.	36.504	36.568	0.	682230.0	3.85	0.064
4.8267943E 02	8.1777921E 04		1.54	6.2685490E 04	1914.36	67.984	-0.454	0.588	1.64	14.553	
90.00	5.9731930E 04	1676185.	282.66	2027.79	0.	37.049	37.116	0.	676300.0	4.05	0.068
4.6997776E 02	7.7526838E 04		1.57	6.4623530E 04	1961.89	67.530	-0.455	0.595	1.68	14.646	
91.00	6.1364798E 04	1677168.	282.83	2078.86	0.	37.587	37.657	0.	670370.0	4.25	0.071
4.5669755E 02	7.3335907E 04		1.60	6.6609644E 04	2010.51	67.075	-0.455	0.602	1.71	14.733	
92.00	6.3026754E 04	1678084.	282.98	2131.05	0.	38.117	38.192	0.	664440.0	4.47	0.074
4.4346494E 02	6.9309437E 04		1.64	6.8644925E 04	2060.22	66.621	-0.455	0.609	1.75	14.812	
93.00	6.4718100E 04	1678951.	283.13	2184.35	0.	38.641	38.719	0.	658510.0	4.69	0.078
4.2967401E 02	6.5353041E 04		1.67	7.0730472E 04	2111.04	66.166	-0.455	0.616	1.78	14.885	
94.00	6.6439137E 04	1679760.	283.26	2238.78	0.	39.157	39.239	0.	652580.0	4.91	0.082
4.1578217E 02	6.1539143E 04		1.71	7.2867396E 04	2162.99	65.712	-0.454	0.623	1.82	14.951	
95.00	6.8190165E 04	1680519.	283.39	2294.34	0.	39.666	39.752	0.	646650.0	5.15	0.086
4.0165789E 02	5.7847390E 04		1.74	7.5056823E 04	2216.05	65.258	-0.454	0.629	1.85	15.010	
96.00	6.9971477E 04	1681231.	283.51	2351.04	0.	40.168	40.258	0.	640720.0	5.39	0.090
3.8729089E 02	5.4275836E 04		1.78	7.7299885E 04	2270.24	64.804	-0.453	0.635	1.89	15.063	
97.00	7.1783370E 04	1681891.	283.62	2408.89	0.	40.663	40.757	0.	634790.0	5.65	0.094
3.7299989E 02	5.0867081E 04		1.82	7.9597728E 04	2325.61	64.352	-0.452	0.642	1.93	15.109	
98.00	7.3626133E 04	1682511.	283.73	2467.90	0.	41.150	41.249	0.	628860.0	5.91	0.098
3.5839520E 02	4.7564426E 04		1.85	8.1951506E 04	2382.13	63.901	-0.451	0.647	1.96	15.149	
99.00	7.5500059E 04	1683083.	283.83	2528.07	0.	41.630	41.733	0.	622930.0	6.18	0.103
3.4407135E 02	4.4443553E 04		1.89	8.4362388E 04	2439.82	63.450	-0.450	0.653	2.00	15.183	

TIME	ALTITUDE	THRUST	ISP	VELOCITY	ACCLRMTR VELOCITY	GAMMA	PSI	ALPHA	WEIGHT	EARTH RANGE	RANGE ANGLE
	DYNAMIC PRESSURE	DRAG	ACC	RANGE	RANGE	RATE	ELEVATION	E RATE	NORML ACC	AR	LOOK ANGLE
100.00	7.7405437E 04	1683618.	283.92	2589.42	0.	42.103	42.211	0.	617000.0	6.46	0.108
	3.2949476E 02	4.1429577E 04	1.93	8.6831546E 04	2498.69	63.001	-0.448	0.659	2.03	15.212	
101.00	7.9342557E 04	1684107.	284.00	2651.95	0.	42.568	42.681	0.	611070.0	6.75	0.112
	3.1547894E 02	3.8619516E 04	1.96	8.9360172E 04	2558.75	62.554	-0.447	0.664	2.07	15.234	
102.00	8.1311704E 04	1684570.	284.08	2715.67	0.	43.026	43.144	0.	605140.0	7.05	0.117
	3.0090231E 02	3.5868841E 04	2.00	9.1949459E 04	2620.01	62.108	-0.445	0.670	2.11	15.252	
103.00	8.3313173E 04	1684997.	284.15	2780.59	0.	43.477	43.600	0.	599210.0	7.36	0.123
	2.8536252E 02	3.3206340E 04	2.04	9.4600624E 04	2682.51	61.663	-0.443	0.675	2.15	15.263	
104.00	8.5347257E 04	1685381.	284.21	2846.73	0.	43.921	44.049	0.	593280.0	7.67	0.128
	2.6963575E 02	3.0708412E 04	2.07	9.7314889E 04	2746.23	61.221	-0.441	0.680	2.18	15.270	
105.00	8.7414247E 04	1685734.	284.27	2914.09	0.	44.358	44.491	0.	587350.0	8.00	0.133
	2.5441105E 02	2.8363664E 04	2.11	1.0009349E 05	2811.18	60.781	-0.439	0.685	2.22	15.272	
106.00	8.9514440E 04	1686060.	284.33	2982.69	0.	44.787	44.926	0.	581420.0	8.34	0.139
	2.3957064E 02	2.6107396E 04	2.15	1.0293768E 05	2877.39	60.342	-0.437	0.689	2.26	15.269	
107.00	9.1648139E 04	1686355.	284.38	3052.53	0.	45.210	45.354	0.	575490.0	8.69	0.145
	2.2557688E 02	2.4006712E 04	2.19	1.0584872E 05	2944.89	59.906	-0.435	0.694	2.30	15.261	
108.00	9.3815643E 04	1686627.	284.42	3123.63	0.	45.625	45.776	0.	569560.0	9.05	0.151
	2.1202505E 02	2.2038037E 04	2.23	1.0882788E 05	3013.64	59.472	-0.433	0.698	2.34	15.248	
109.00	9.6017258E 04	1686872.	284.46	3195.99	0.	46.034	46.191	0.	563630.0	9.42	0.157
	1.9924717E 02	2.0229173E 04	2.27	1.1187646E 05	3083.71	59.041	-0.430	0.702	2.38	15.232	
110.00	9.8253293E 04	1687098.	284.50	3269.64	0.	46.435	46.599	0.	557700.0	9.80	0.163
	1.8686586E 02	1.8534555E 04	2.31	1.1499575E 05	3155.08	58.613	-0.427	0.706	2.41	15.211	
111.00	1.0052406E 05	1687302.	284.54	3344.58	0.	46.830	47.000	0.	551770.0	10.20	0.170
	1.7524587E 02	1.6984221E 04	2.35	1.1818708E 05	3227.79	58.186	-0.425	0.710	2.45	15.187	
112.00	1.0282988E 05	1687488.	284.57	3420.84	0.	47.218	47.395	0.	545840.0	10.60	0.177
	1.6413205E 02	1.5546405E 04	2.39	1.2145177E 05	3301.82	57.763	-0.422	0.714	2.49	15.158	
113.00	1.0517108E 05	1687655.	284.60	3498.41	0.	47.600	47.783	0.	539910.0	11.02	0.184
	1.5373759E 02	1.4235157E 04	2.43	1.2479116E 05	3377.22	57.342	-0.419	0.718	2.54	15.126	
114.00	1.0754799E 05	1687808.	284.62	3577.33	0.	47.975	48.165	0.	533980.0	11.45	0.191
	1.4377951E 02	1.3018030E 04	2.47	1.2820664E 05	3453.96	56.925	-0.416	0.721	2.58	15.090	
115.00	1.0996094E 05	1687948.	284.65	3657.60	0.	48.343	48.541	0.	528050.0	11.89	0.198
	1.3427378E 02	1.1891581E 04	2.52	1.3169957E 05	3532.12	56.510	-0.413	0.725	2.62	15.051	
116.00	1.1241029E 05	1688074.	284.67	3739.25	0.	48.705	48.911	0.	522120.0	12.34	0.206
	1.2534941E 02	1.0862208E 04	2.56	1.3527135E 05	3611.68	56.098	-0.410	0.728	2.66	15.009	

TIME	ALTITUDE	THRUST	ISP	VELOCITY	ACCLRMTR VELOCITY	GAMMA	PSI	ALPHA	WEIGHT	EARTH RANGE	RANGE ANGLE
	DYNAMIC PRESSURE	DRAG	ACC	RANGE	RANGE	RATE	ELEVATION	E RATE	NORML ACC	AR LOOK	ANGLE
117.00	1.1489640E 05	1688188.	284.69	3822.30	0.	49.061	49.274	0.	516190.0	12.81	0.213
	1.1684101E 02	9.9105831E 03	2.60	1.3892342E 05	3692.68	55.690	-0.407	0.731	2.70	14.964	
118.00	1.1741962E 05	1688292.	284.70	3906.77	0.	49.410	49.631	0.	510260.0	13.29	0.221
	1.0888915E 02	9.0441971E 03	2.65	1.4265720E 05	3775.12	55.284	-0.404	0.734	2.75	14.916	
119.00	1.1998033E 05	1688385.	284.72	3992.68	0.	49.753	49.983	0.	504330.0	13.78	0.230
	1.0137257E 02	8.2484667E 03	2.69	1.4647417E 05	3859.06	54.882	-0.401	0.737	2.79	14.865	
120.00	1.2257894E 05	1688470.	284.73	4080.05	0.	50.090	50.328	0.	498400.0	14.28	0.238
	9.4267031E 01	7.5175731E 03	2.74	1.5037581E 05	3944.48	54.483	-0.397	0.739	2.84	14.811	
121.00	1.2521583E 05	1688547.	284.75	4168.91	0.	50.421	50.668	0.	492470.0	14.80	0.247
	8.7645983E 01	6.8536800E 03	2.79	1.5436363E 05	4031.43	54.087	-0.394	0.742	2.88	14.755	
122.00	1.2789142E 05	1688616.	284.76	4259.28	0.	50.746	51.002	0.	486540.0	15.33	0.256
	8.1397171E 01	6.2477106E 03	2.83	1.5843918E 05	4119.91	53.695	-0.391	0.744	2.93	14.697	
123.00	1.3060614E 05	1688678.	284.77	4351.20	0.	51.065	51.330	0.	480610.0	15.88	0.265
	7.5529220E 01	5.6967158E 03	2.88	1.6260401E 05	4210.01	53.306	-0.387	0.746	2.98	14.636	
124.00	1.3336043E 05	1688734.	284.78	4444.68	0.	51.379	51.653	0.	474680.0	16.44	0.274
	7.0064545E 01	5.1957028E 03	2.93	1.6685973E 05	4301.70	52.920	-0.384	0.749	3.02	14.573	
125.00	1.3615475E 05	1688785.	284.79	4539.77	0.	51.686	51.970	0.	468750.0	17.02	0.284
	6.4929963E 01	4.7364990E 03	2.98	1.7120794E 05	4395.01	52.538	-0.381	0.751	3.07	14.508	
126.00	1.3898959E 05	1688830.	284.79	4636.50	0.	51.988	52.282	0.	462820.0	17.61	0.293
	6.0119820E 01	4.3163266E 03	3.03	1.7565031E 05	4490.01	52.159	-0.377	0.752	3.12	14.441	
127.00	1.4186542E 05	1688871.	284.80	4734.89	0.	52.285	52.588	0.	456890.0	18.21	0.303
	5.5655603E 01	3.9345284E 03	3.08	1.8018853E 05	4586.70	51.783	-0.374	0.754	3.18	14.372	
128.00	1.4478276E 05	1688908.	284.81	4834.98	0.	52.576	52.890	0.	450960.0	18.83	0.314
	5.1478772E 01	3.5849493E 03	3.14	1.8482431E 05	4685.14	51.411	-0.370	0.756	3.23	14.301	
129.00	1.4774214E 05	1688941.	284.81	4936.81	0.	52.861	53.186	0.	445030.0	19.46	0.324
	4.7571844E 01	3.2646528E 03	3.19	1.8955941E 05	4785.36	51.043	-0.367	0.757	3.28	14.229	
130.00	1.5074412E 05	1688971.	284.82	5040.42	0.	53.141	53.477	0.	439100.0	20.11	0.335
	4.3946635E 01	2.9728910E 03	3.25	1.9439564E 05	4887.39	50.678	-0.363	0.759	3.34	14.155	
131.00	1.5378925E 05	1688998.	284.82	5145.85	0.	53.416	53.763	0.	433170.0	20.78	0.346
	4.0549076E 01	2.7046027E 03	3.31	1.9933482E 05	4991.27	50.316	-0.360	0.760	3.39	14.079	

[redacted]

BURNOUT STAGE 1

VELOCITY GRAVITY LOSS=	3656.46	AVERAGE ISP OF STAGE=	272.08
VELOCITY DRAG LOSS=	292.00	WT PROPELLANT BURNED=	776830.00
ATTACK VELOCITY LOSS=	0.		
STAGE VELOCITY INCREASE=	5145.85	O/O OF IDEAL VELOCITY=	56.58
STAGE IDEAL VELOCITY=	9094.31		

BEGIN THRUST ATTITUDE CONTROL PROGRAM 1

STAGE CUTOFF PARAMETERS FOR POSSIBLE RE-ENTRY AT THIS POINT

	TIME	ALTITUDE	VELOCITY	ACLRMTR VEL	GAMMA	EARTH RANGE
	0.13100000E 03	0.15378925E 06	0.51458510E 04	0.	0.53416225E 02	0.20781300E 02
OCTAL	210406000000	222454275202	215501473170	000000000000	206653250667	205514400325

[redacted]

BEGIN STAGE 2
INTEGRATION STEP SIZE= 10.000
TIME CUTOFF AT 485.00 SEC

TIME	ALTITUDE	DYNAMIC PRESSURE	THRUST	DRAG	ISP	ACC	VELOCITY	RANGE	ACCLRMTR VELOCITY	RANGE	GAMMA	RATE	PSI	ELEVATION	ALPHA	E RATE	WEIGHT	NORML ACC	EARTH RANGE	AR	RANGE ANGLE	LOOK ANGLE
131.00	1.5378925E 05	4.0549076E 01	200000.	0.	421.94	-0.11	5145.85	1.9933482E 05	0.	4991.27	53.416	50.316	10.000	-0.360	43.763	0.760	300833.0	3.39	20.78	14.079	0.346	
140.00	1.8099833E 05	1.5258158E 01	200000.	0.	421.94	-0.08	5118.50	2.4430166E 05	0.	4998.64	54.395	47.582	11.521	-0.258	43.321	0.305	296567.0	0.32	26.87	-30.897	0.448	
150.00	2.1032826E 05	5.4474526E 00	200000.	0.	421.94	-0.05	5096.88	2.9427962E 05	0.	4996.23	55.505	45.339	13.211	-0.196	42.855	0.310	291827.0	0.31	33.68	-31.450	0.561	
160.00	2.3873956E 05	1.6919636E 00	200000.	0.	421.94	-0.02	5084.65	3.4422457E 05	0.	4993.14	56.637	43.573	14.901	-0.160	42.412	0.315	287087.0	0.32	40.55	-31.526	0.676	
170.00	2.6626362E 05	4.2127548E-01	200000.	0.	421.94	0.01	5081.98	3.9415588E 05	0.	4994.01	57.787	42.098	16.591	-0.137	41.987	0.319	282347.0	0.32	47.50	-31.311	0.792	
180.00	2.9293090E 05	8.2603009E-02	200000.	0.	421.94	0.04	5089.06	4.4412553E 05	0.	5001.07	58.950	40.811	18.281	-0.122	41.577	0.323	277607.0	0.32	54.52	-30.908	0.909	
190.00	3.1877092E 05	1.6244822E-02	200000.	0.	421.94	0.07	5106.04	4.9420227E 05	0.	5015.58	60.122	39.652	19.971	-0.111	41.178	0.326	272867.0	0.33	61.64	-30.377	1.027	
200.00	3.4381225E 05	4.0816968E-03	200000.	0.	421.94	0.10	5133.11	5.4446461E 05	0.	5038.30	61.299	38.582	21.661	-0.103	40.786	0.328	268127.0	0.34	68.87	-29.757	1.148	
210.00	3.6808253E 05	1.0619156E-03	200000.	0.	421.94	0.13	5170.42	5.9499744E 05	0.	5069.75	62.476	37.578	23.351	-0.098	40.395	0.330	263387.0	0.36	76.22	-29.071	1.270	
220.00	3.9160848E 05	4.1951867E-04	200000.	0.	421.94	0.16	5218.13	6.4589022E 05	0.	5110.35	63.648	36.622	25.041	-0.094	40.002	0.331	258647.0	0.37	83.70	-28.337	1.395	
230.00	4.1441585E 05	2.1728041E-04	200000.	0.	421.94	0.20	5276.40	6.9723595E 05	0.	5160.40	64.811	35.703	26.731	-0.090	39.602	0.331	253907.0	0.39	91.32	-27.566	1.522	
240.00	4.3652953E 05	1.3164052E-04	200000.	0.	421.94	0.23	5345.39	7.4913076E 05	0.	5220.20	65.961	34.812	28.421	-0.088	39.192	0.331	249167.0	0.40	99.10	-26.767	1.652	
250.00	4.5797344E 05	8.8405125E-05	200000.	0.	421.94	0.27	5425.25	8.0167341E 05	0.	5290.01	67.093	33.942	30.111	-0.086	38.766	0.330	244427.0	0.42	107.05	-25.947	1.784	
260.00	4.7877064E 05	6.3869588E-05	200000.	0.	421.94	0.30	5516.13	8.5496527E 05	0.	5370.09	68.204	33.090	31.801	-0.084	38.323	0.329	239687.0	0.45	115.19	-25.109	1.920	
270.00	4.9894330E 05	4.8758505E-05	200000.	0.	421.94	0.33	5618.20	9.0911013E 05	0.	5460.66	69.291	32.251	33.491	-0.083	37.858	0.327	234947.0	0.47	123.53	-24.258	2.059	
280.00	5.1851273E 05	3.8831401E-05	200000.	0.	421.94	0.37	5731.60	9.6421422E 05	0.	5561.97	70.349	31.424	35.181	-0.082	37.369	0.325	230207.0	0.49	132.08	-23.395	2.201	

[redacted]

TIME	ALTITUDE	THRUST	ISP	VELOCITY	ACCLRMTR VELOCITY	GAMMA	PSI	ALPHA	WEIGHT	EARTH	RANGE
	DYNAMIC PRESSURE	DRAG	ACC	RANGE	RANGE	RATE	ELEVATION	E RATE	NORML ACC	RANGE AR	ANGLE LOOK ANGLE
290.00	5.3749937E 05	200000.	421.94	5856.50	0.	71.377	36.871	36.854	225467.0	140.86	2.348
	3.2055355E-05 0.		0.41	1.0203862E 06	5674.27	30.606	-0.081	0.322	0.52	-22.523	
300.00	5.5592290E 05	200000.	421.94	5993.08	0.	72.373	38.561	36.310	220727.0	149.88	2.498
	2.8102949E-05 0.		0.44	1.0777371E 06	5797.80	29.795	-0.081	0.318	0.55	-21.644	
310.00	5.7380214E 05	200000.	421.94	6141.51	0.	73.334	40.251	35.736	215987.0	159.17	2.653
	2.5135641E-05 0.		0.48	1.1363806E 06	5932.83	28.992	-0.080	0.314	0.57	-20.757	
320.00	5.9115523E 05	200000.	421.94	6301.99	0.	74.260	41.941	35.131	211247.0	168.72	2.812
	2.3065830E-05 0.		0.52	1.1964329E 06	6079.61	28.194	-0.079	0.310	0.60	-19.865	
330.00	6.0799952E 05	200000.	421.94	6474.74	0.	75.149	43.631	34.494	206507.0	178.57	2.976
	2.1390251E-05 0.		0.56	1.2580129E 06	6238.43	27.402	-0.079	0.306	0.63	-18.967	
340.00	6.2435172E 05	200000.	421.94	6659.97	0.	76.000	45.321	33.825	201767.0	188.73	3.145
	1.9990965E-05 0.		0.60	1.3212425E 06	6409.56	26.616	-0.078	0.301	0.67	-18.063	
350.00	6.4022787E 05	200000.	421.94	6857.94	0.	76.814	47.011	33.124	197027.0	199.22	3.320
	1.8834938E-05 0.		0.64	1.3862462E 06	6593.33	25.833	-0.078	0.296	0.70	-17.156	
360.00	6.5564346E 05	200000.	421.94	7068.92	0.	77.591	48.701	32.391	192287.0	210.05	3.501
	1.7875753E-05 0.		0.68	1.4531521E 06	6790.03	25.056	-0.078	0.291	0.74	-16.243	
370.00	6.7061344E 05	200000.	421.94	7293.21	0.	78.330	50.391	31.627	187547.0	221.24	3.687
	1.7077873E-05 0.		0.72	1.5220912E 06	7000.04	24.283	-0.077	0.285	0.77	-15.326	
380.00	6.8515227E 05	200000.	421.94	7531.14	0.	79.033	52.081	30.832	182807.0	232.82	3.880
	1.6452107E-05 0.		0.76	1.5931983E 06	7223.69	23.515	-0.077	0.280	0.81	-14.404	
390.00	6.9927403E 05	200000.	421.94	7783.07	0.	79.699	53.771	30.008	178067.0	244.80	4.080
	1.5975821E-05 0.		0.81	1.6666119E 06	7461.40	22.751	-0.076	0.274	0.85	-13.478	
400.00	7.1299249E 05	200000.	421.94	8049.40	0.	80.330	55.461	29.155	173327.0	257.20	4.287
	1.5591331E-05 0.		0.85	1.7424746E 06	7713.58	21.992	-0.076	0.268	0.89	-12.547	
410.00	7.2632114E 05	200000.	421.94	8330.57	0.	80.926	57.151	28.276	168587.0	270.05	4.501
	1.5288561E-05 0.		0.90	1.8209332E 06	7980.68	21.238	-0.075	0.262	0.93	-11.611	
420.00	7.3927334E 05	200000.	421.94	8627.08	0.	81.489	58.841	27.370	163847.0	283.36	4.723
	1.5059274E-05 0.		0.95	1.9021395E 06	8263.20	20.489	-0.075	0.256	0.98	-10.670	
430.00	7.5186241E 05	200000.	421.94	8939.46	0.	82.019	60.531	26.441	159107.0	297.16	4.953
	1.4896826E-05 0.		1.00	1.9862504E 06	8561.68	19.745	-0.074	0.249	1.03	-9.724	
440.00	7.6410173E 05	200000.	421.94	9268.30	0.	82.518	62.221	25.488	154367.0	311.48	5.191
	1.4795962E-05 0.		1.05	2.0734283E 06	8876.70	19.006	-0.074	0.243	1.08	-8.773	
450.00	7.7600484E 05	200000.	421.94	9614.26	0.	82.986	63.911	24.514	149627.0	326.33	5.439
	1.4751331E-05 0.		1.10	2.1638418E 06	9208.92	18.272	-0.073	0.237	1.13	-7.817	

[redacted]

[redacted]

TIME	ALTITUDE	THRUST	ISP	VELOCITY	ACCLRMTR VELOCITY	GAMMA	PSI	ALPHA	WEIGHT	EARTH RANGE	RANGE ANGLE
DYNAMIC	PRESSURE	DRAG	ACC	RANGE	RANGE	RATE	ELEVATION	E RATE	NORML ACC	AR	LOOK ANGLE
460.00	7.8758564E 05	200000.	421.94	9978.09	0.	83.426	65.601	23.520	144887.0	341.75	5.696
	1.4761399E-05	0.	1.16	2.2576663E 06	9559.03	17.543	-0.073	0.230	1.18	-6.856	
470.00	7.9885848E 05	200000.	421.94	10360.58	0.	83.836	67.291	22.508	140147.0	357.76	5.963
	1.4822423E-05	0.	1.22	2.3550847E 06	9927.83	16.819	-0.072	0.223	1.24	-5.890	
480.00	8.0983834E 05	200000.	421.94	10762.65	0.	84.220	68.981	21.479	135407.0	374.39	6.240
	1.4936446E-05	0.	1.28	2.4562881E 06	10316.18	16.101	-0.072	0.216	1.30	-4.918	
490.00	8.2054104E 05	200000.	421.94	11185.31	0.	84.578	70.671	20.435	130667.0	391.68	6.528
	1.5097779E-05	0.	1.35	2.5614767E 06	10725.05	15.388	-0.071	0.209	1.36	-3.941	
500.00	8.3098344E 05	200000.	421.94	11629.69	0.	84.910	72.361	19.376	125927.0	409.65	6.827
	1.5305193E-05	0.	1.42	2.6708611E 06	11155.51	14.680	-0.071	0.202	1.43	-2.959	
510.00	8.4118360E 05	200000.	421.94	12097.05	0.	85.218	74.051	18.305	121187.0	428.34	7.139
	1.5558370E-05	0.	1.49	2.7846630E 06	11608.79	13.978	-0.070	0.194	1.50	-1.971	
520.00	8.5116117E 05	200000.	421.94	12588.84	0.	85.502	75.741	17.224	116447.0	447.78	7.463
	1.5857385E-05	0.	1.57	2.9031173E 06	12086.23	13.280	-0.070	0.186	1.58	-0.979	
530.00	8.6093752E 05	200000.	421.94	13106.66	0.	85.763	77.431	16.132	111707.0	468.02	7.800
	1.6202669E-05	0.	1.65	3.0264732E 06	12589.38	12.588	-0.069	0.178	1.66	0.019	
540.00	8.7053623E 05	200000.	421.94	13652.36	0.	86.002	79.121	15.032	106967.0	489.09	8.151
	1.6595014E-05	0.	1.74	3.1549963E 06	13119.99	11.900	-0.069	0.169	1.75	1.021	
550.00	8.7998329E 05	200000.	421.94	14228.03	0.	86.220	80.811	13.926	102227.0	511.04	8.517
	1.7035552E-05	0.	1.84	3.2889710E 06	13680.05	11.216	-0.068	0.160	1.85	2.027	
560.00	8.8930765E 05	200000.	421.94	14836.07	0.	86.416	82.501	12.814	97487.0	533.92	8.898
	1.7524160E-05	0.	1.94	3.4287031E 06	14271.87	10.537	-0.068	0.150	1.95	3.038	
570.00	8.9854162E 05	200000.	421.94	15479.27	0.	86.592	84.191	11.697	92747.0	557.77	9.296
	1.8064820E-05	0.	2.06	3.5745230E 06	14898.08	9.862	-0.067	0.139	2.06	4.053	
580.00	9.0772146E 05	200000.	421.94	16160.86	0.	86.749	85.881	10.579	88007.0	582.67	9.711
	1.8660202E-05	0.	2.18	3.7267895E 06	15561.77	9.190	-0.067	0.128	2.19	5.071	
590.00	9.1688796E 05	200000.	421.94	16884.60	0.	86.885	87.571	9.458	83267.0	608.66	10.144
	1.9310324E-05	0.	2.32	3.8858951E 06	16266.53	8.521	-0.067	0.116	2.32	6.092	
600.00	9.2608725E 05	200000.	421.94	17654.95	0.	87.002	89.261	8.338	78527.0	635.82	10.597
	2.0017115E-05	0.	2.47	4.0522711E 06	17016.62	7.855	-0.067	0.103	2.47	7.116	
610.00	9.3537161E 05	200000.	421.94	18477.22	0.	87.101	90.951	7.220	73787.0	664.22	11.070
	2.0783239E-05	0.	2.64	4.2263953E 06	17817.10	7.191	-0.066	0.089	2.64	8.142	
616.00	9.4100747E 05	200000.	421.94	18998.11	0.	87.151	91.965	6.550	70943.0	681.89	11.365
	2.1272648E-05	0.	2.76	4.3348083E 06	18324.07	6.793	-0.066	0.080	2.76	8.758	

[redacted]

BURNOUT STAGE 2

VELOCITY GRAVITY LOSS=	3667.97	AVERAGE ISP OF STAGE=	421.94
VELOCITY DRAG LOSS=	0.	WT PROPELLANT BURNED=	229890.00
ATTACK VELOCITY LOSS=	2092.04		
STAGE VELOCITY INCREASE=	13852.26	O/O OF IDEAL VELOCITY=	70.63
STAGE IDEAL VELOCITY=	19612.27		

STAGE CUTOFF PARAMETERS FOR POSSIBLE RE-ENTRY AT THIS POINT

	TIME	ALTITUDE	VELOCITY	ACLRMTR VEL	GAMMA	EARTH RANGE
	0.61600000E 03	0.94100747E 06	0.18998109E 05	0.	0.87150615E 02	0.68189169E 03
OCTAL	212464000000	224713363675	217450660676	000000000000	207534464353	212524744214

[redacted]

BEGIN STAGE 3
INTEGRATION STEP SIZE= 10.000
TIME CUTOFF AT 420.00 SEC

TIME	ALTITUDE	THRUST	ISP	VELOCITY	ACCLRMTR VELOCITY	GAMMA	PSI	ALPHA	WEIGHT	EARTH RANGE	RANGE ANGLE
	DYNAMIC PRESSURE	DRAG	ACC	RANGE	RANGE	RATE	ELEVATION	E RATE	NORML ACC	AR	LOOK ANGLE
616.00	9.4100747E 05	30000.	419.58	18998.11	0.	87.151	91.965	6.550	45000.0	681.89	11.365
	2.1272648E-05	0.	0.62	4.3348083E 06	18324.07	6.793	-0.066	0.080	2.76	8.758	
620.00	9.4470928E 05	30000.	419.58	19077.92	0.	87.277	92.641	6.200	44714.0	693.86	11.564
	2.1002302E-05	0.	0.62	4.4082475E 06	18395.64	6.529	-0.066	0.325	0.70	9.170	
630.00	9.5329988E 05	30000.	419.58	19281.24	0.	87.588	94.331	5.323	43999.0	724.00	12.066
	2.0427321E-05	0.	0.64	4.5931081E 06	18577.08	5.878	-0.064	0.322	0.72	10.209	
640.00	9.6094084E 05	30000.	419.58	19490.01	0.	87.893	96.021	4.446	43284.0	754.47	12.574
	1.9986817E-05	0.	0.66	4.7798014E 06	18762.21	5.240	-0.063	0.320	0.73	11.261	
650.00	9.6763053E 05	30000.	419.58	19704.28	0.	88.193	97.711	3.569	42569.0	785.26	13.087
	1.9671251E-05	0.	0.67	4.9683646E 06	18951.07	4.613	-0.062	0.318	0.75	12.324	
660.00	9.7336715E 05	30000.	419.58	19924.10	0.	88.487	99.401	2.692	41854.0	816.39	13.606
	1.9473741E-05	0.	0.69	5.1588355E 06	19143.75	3.995	-0.061	0.315	0.76	13.396	
670.00	9.7814876E 05	30000.	419.58	20149.52	0.	88.776	101.091	1.816	41139.0	847.86	14.131
	1.9389796E-05	0.	0.71	5.3512526E 06	19340.31	3.386	-0.061	0.313	0.78	14.477	
680.00	9.8197325E 05	30000.	419.58	20380.59	0.	89.060	102.781	0.940	40424.0	879.69	14.661
	1.9417147E-05	0.	0.73	5.5456548E 06	19540.80	2.784	-0.060	0.310	0.79	15.565	
690.00	9.8483839E 05	30000.	419.58	20617.39	0.	89.337	104.471	0.064	39709.0	911.88	15.198
	1.9555644E-05	0.	0.74	5.7420818E 06	19745.28	2.189	-0.059	0.308	0.81	16.660	
700.00	9.8674178E 05	30000.	419.58	20859.97	0.	89.610	106.161	-0.811	38994.0	944.45	15.741
	1.9807243E-05	0.	0.76	5.9405737E 06	19953.79	1.600	-0.059	0.305	0.82	17.761	
710.00	9.8768090E 05	30000.	419.58	21108.42	0.	89.876	107.851	-1.685	38279.0	977.41	16.290
	2.0176063E-05	0.	0.78	6.1411712E 06	20166.39	1.016	-0.058	0.302	0.84	18.867	
720.00	9.8765311E 05	30000.	419.58	21362.82	0.	90.137	109.541	-2.558	37564.0	1010.76	16.846
	2.0668515E-05	0.	0.80	6.3439152E 06	20383.11	0.436	-0.058	0.299	0.85	19.977	
730.00	9.8665562E 05	30000.	419.58	21623.26	0.	90.393	111.231	-3.430	36849.0	1044.51	17.403
	2.1293509E-05	0.	0.82	6.5488473E 06	20604.02	-0.139	-0.057	0.297	0.87	21.092	
740.00	9.8468550E 05	30000.	419.58	21889.82	0.	90.643	112.921	-4.300	36134.0	1078.68	17.978
	2.2062753E-05	0.	0.84	6.7560096E 06	20829.17	-0.712	-0.057	0.294	0.89	22.209	
750.00	9.8173970E 05	30000.	419.58	22162.62	0.	90.888	114.611	-5.169	35419.0	1113.27	18.554
	2.2991165E-05	0.	0.86	6.9654449E 06	21058.59	-1.281	-0.057	0.291	0.91	23.330	
760.00	9.7781501E 05	30000.	419.58	22441.77	0.	91.127	116.301	-6.036	34704.0	1148.30	19.138
	2.4097401E-05	0.	0.88	7.1771960E 06	21292.36	-1.848	-0.057	0.288	0.92	24.453	

[redacted]

TIME	ALTITUDE	THRUST	ISP	VELOCITY	ACCLRMTR VELOCITY	GAMMA	PSI	ALPHA	WEIGHT	EARTH RANGE	RANGE ANGLE
DYNAMIC PRESSURE		DRAG	ACC	RANGE	RANGE	RATE	ELEVATION	E RATE	NORML ACC	AR	LOOK ANGLE
770.00	9.7290807E 05	30000.	419.58	22727.39	0.	91.361	117.991	-6.900	33989.0	1183.78	19.729
2.5404537E-05	0.		0.90	7.3913066E 06	21530.52		-2.413	-0.056	0.285	0.94	25.578
780.00	9.6701534E 05	30000.	419.58	23019.62	0.	91.590	119.681	-7.763	33274.0	1219.72	20.328
2.6940970E-05	0.		0.92	7.6078212E 06	21773.15		-2.977	-0.056	0.282	0.96	26.704
790.00	9.6013312E 05	30000.	419.58	23318.60	0.	91.813	121.371	-8.623	32559.0	1256.13	20.935
2.8741538E-05	0.		0.94	7.8267847E 06	22020.30		-3.539	-0.056	0.279	0.98	27.832
800.00	9.5225750E 05	30000.	419.58	23624.49	0.	92.031	123.061	-9.480	31844.0	1293.02	21.550
3.0848975E-05	0.		0.96	8.0482424E 06	22272.05		-4.100	-0.056	0.276	1.00	28.961
810.00	9.4338435E 05	30000.	419.58	23937.46	0.	92.244	124.751	-10.334	31129.0	1330.41	22.173
3.3315795E-05	0.		0.98	8.2722411E 06	22528.48		-4.661	-0.056	0.273	1.02	30.090
820.00	9.3350928E 05	30000.	419.58	24257.71	0.	92.452	126.441	-11.185	30414.0	1368.31	22.805
3.6206667E-05	0.		1.01	8.4988278E 06	22789.67		-5.221	-0.056	0.270	1.04	31.220
830.00	9.2262759E 05	30000.	419.58	24585.43	0.	92.655	128.131	-12.032	29699.0	1406.73	23.445
3.9601509E-05	0.		1.03	8.7280505E 06	23055.72		-5.781	-0.056	0.267	1.06	32.350
840.00	9.1073430E 05	30000.	419.58	24920.84	0.	92.852	129.821	-12.875	28984.0	1445.68	24.094
4.3599454E-05	0.		1.05	8.9599586E 06	23326.73		-6.342	-0.056	0.264	1.09	33.479
850.00	8.9782397E 05	30000.	419.58	25264.21	0.	93.045	131.511	-13.713	28269.0	1485.18	24.752
4.8325724E-05	0.		1.08	9.1946018E 06	23602.82		-6.903	-0.056	0.261	1.11	34.608
860.00	8.8389077E 05	30000.	419.58	25615.78	0.	93.233	133.201	-14.548	27554.0	1525.25	25.420
5.3950385E-05	0.		1.11	9.4320321E 06	23884.10		-7.465	-0.056	0.258	1.14	35.736
870.00	8.6892835E 05	30000.	419.58	25975.85	0.	93.416	134.891	-15.377	26839.0	1565.90	26.098
6.0657692E-05	0.		1.13	9.6723015E 06	24170.72		-8.028	-0.056	0.255	1.16	36.863
880.00	8.5292975E 05	30000.	419.58	26344.75	0.	93.595	136.581	-16.201	26124.0	1607.14	26.785
6.8706123E-05	0.		1.16	9.9154644E 06	24462.82		-8.592	-0.057	0.252	1.19	37.989
890.00	8.3588732E 05	30000.	419.58	26722.83	0.	93.769	138.271	-17.019	25409.0	1649.00	27.483
7.8418600E-05	0.		1.19	1.0161577E 07	24760.57		-9.158	-0.057	0.249	1.22	39.113
900.00	8.1779263E 05	30000.	419.58	27110.48	0.	93.939	139.961	-17.831	24694.0	1691.49	28.191
9.0212620E-05	0.		1.22	1.0410695E 07	25064.16		-9.726	-0.057	0.247	1.24	40.235
910.00	7.9863627E 05	30000.	419.58	27508.11	0.	94.105	141.651	-18.636	23979.0	1734.62	28.910
1.0463550E-04	0.		1.25	1.0662880E 07	25373.79		-10.296	-0.057	0.244	1.28	41.355
920.00	7.7840777E 05	30000.	419.58	27916.22	0.	94.266	143.341	-19.435	23264.0	1778.42	29.640
1.2247847E-04	0.		1.29	1.0918192E 07	25689.68		-10.868	-0.057	0.242	1.31	42.473
930.00	7.5709539E 05	30000.	419.58	28335.31	0.	94.424	145.031	-20.225	22549.0	1822.91	30.381
1.4468224E-04	0.		1.32	1.1176695E 07	26012.09		-11.442	-0.058	0.240	1.34	43.589

[redacted]

TIME / DYNAMIC PRESSURE	ALTITUDE	THRUST / DRAG	ISP / ACC	VELOCITY / RANGE	ACCLRMTR VELOCITY / RANGE	GAMMA / RATE	PSI / ELEVATION	ALPHA / E RATE	WEIGHT / NORML ACC	EARTH RANGE / AR	RANGE ANGLE / LOOK ANGLE
940.00	7.3468589E 05	30000.	419.58	28765.97	0.	94.579	146.721	-21.008	21834.0	1868.11	31.134
1.7253705E-04	0.		1.36	1.1438456E 07	26341.30	-12.020		-0.058	0.238	1.38	44.701
950.00	7.1116431E 05	30000.	419.58	29208.85	0.	94.729	148.411	-21.782	21119.0	1914.04	31.900
2.0781150E-04	0.		1.40	1.1703544E 07	26677.62	-12.601		-0.058	0.237	1.42	45.810
960.00	6.8651369E 05	30000.	419.58	29664.66	0.	94.877	150.101	-22.546	20404.0	1960.72	32.678
2.5291700E-04	0.		1.44	1.1972033E 07	27021.40	-13.185		-0.059	0.235	1.46	46.916
970.00	6.6071467E 05	30000.	419.58	30134.22	0.	95.022	151.791	-23.300	19689.0	2008.18	33.469
3.1312585E-04	0.		1.48	1.2243998E 07	27373.03	-13.772		-0.059	0.235	1.50	48.019
980.00	6.3374519E 05	30000.	419.58	30618.42	0.	95.165	153.481	-24.043	18974.0	2056.44	34.273
3.9390392E-04	0.		1.53	1.2519521E 07	27732.96	-14.364		-0.059	0.235	1.55	49.117
990.00	6.0557990E 05	30000.	419.58	31118.29	0.	95.305	155.171	-24.774	18259.0	2105.54	35.092
5.0331675E-04	0.		1.58	1.2798687E 07	28101.68	-14.960		-0.060	0.236	1.60	50.211
1000.00	5.7618966E 05	30000.	419.58	31634.97	0.	95.444	156.861	-25.493	17544.0	2155.50	35.924
6.5391667E-04	0.		1.63	1.3081586E 07	28479.75	-15.561		-0.060	0.237	1.65	51.300
1010.00	5.4554085E 05	30000.	419.58	32169.78	0.	95.582	158.551	-26.197	16829.0	2206.36	36.772
8.9270664E-04	0.		1.69	1.3368315E 07	28867.81	-16.167		-0.061	0.240	1.71	52.384
1020.00	5.1359454E 05	30000.	419.58	32724.21	0.	95.719	160.241	-26.887	16114.0	2258.15	37.635
1.3504317E-03	0.		1.76	1.3658978E 07	29266.58	-16.778		-0.061	0.243	1.77	53.463
1030.00	4.8030551E 05	30000.	419.58	33299.96	0.	95.856	161.931	-27.560	15399.0	2310.91	38.514
2.2710027E-03	0.		1.82	1.3953685E 07	29676.91	-17.395		-0.062	0.249	1.84	54.536
1036.00	4.5966603E 05	30000.	419.58	33656.46	0.	95.939	162.945	-27.956	14970.0	2343.05	39.050
3.2982407E-03	0.		1.87	1.4132500E 07	29929.04	-17.768		-0.062	0.253	1.89	55.177

BURNOUT STAGE 3

VELOCITY GRAVITY LOSS=	-489.29	AVERAGE ISP OF STAGE=	419.58
VELOCITY DRAG LOSS=	0.	WT PROPELLANT BURNED=	30030.0[illegible]
ATTACK VELOCITY LOSS=	688.77		
STAGE VELOCITY INCREASE=	14658.35	O/O OF IDEAL VELOCITY=	98.66
STAGE IDEAL VELOCITY=	14857.83		

STAGE CUTOFF PARAMETERS FOR POSSIBLE RE-ENTRY AT THIS POINT

	TIME	ALTITUDE	VELOCITY	ACLRMTR VEL	GAMMA	EARTH RANGE
	0.10360000E 04	0.45966602E 06	0.33656459E 05	0.	0.95939068E 02	0.23430483E 04
OCTAL	213403000000	223700711007	220406741656	000000000000	207577603155	214444703057

FREE FLIGHT-TABULATING PARAMETERS AT INTERVALS OF 5.00 SECONDS-FOR 1000.00 SECONDS

TIME	ALTITUDE	VELOCITY	GAMMA	EARTH RANGE	EARTH RANGE ANGLE
1036.00	0.45966602E 06	33656.46	95.939	2343.05	39.050
1041.00	0.44252650E 06	33672.18	95.751	2370.00	39.499
1046.00	0.42592674E 06	33687.42	95.563	2397.00	39.949
1051.00	0.40987175E 06	33702.17	95.374	2424.04	40.400
1056.00	0.39436175E 06	33716.44	95.185	2451.13	40.851
1061.00	0.37939975E 06	33730.22	94.996	2478.25	41.303
1066.00	0.36498625E 06	33743.50	94.807	2505.41	41.756
1071.00	0.35112499E 06	33756.29	94.617	2532.60	42.209
1076.00	0.33781600E 06	33768.59	94.427	2559.83	42.663
1081.00	0.32506125E 06	33780.38	94.237	2587.09	43.117
1086.00	0.31286225E 06	33791.66	94.046	2614.38	43.572
1091.00	0.30122074E 06	33802.44	93.855	2641.71	44.027
1096.00	0.29013575E 06	33812.71	93.664	2669.06	44.483
1101.00	0.27961150E 06	33822.47	93.473	2696.44	44.940
1106.00	0.26964749E 06	33831.71	93.281	2723.85	45.397
1111.00	0.26024675E 06	33840.44	93.090	2751.29	45.854
1116.00	0.25140800E 06	33848.65	92.898	2778.74	46.311
1121.00	0.24313400E 06	33856.35	92.706	2806.22	46.769
1126.00	0.23542500E 06	33863.51	92.514	2833.72	47.228
1131.00	0.22828200E 06	33870.16	92.321	2861.24	47.686
1136.00	0.22170550E 06	33876.28	92.129	2888.78	48.145
1141.00	0.21569774E 06	33881.88	91.936	2916.33	48.604
1146.00	0.21025775E 06	33886.95	91.744	2943.90	49.064
1151.00	0.20538600E 06	33891.49	91.551	2971.49	49.524
1156.00	0.20108475E 06	33895.50	91.358	2999.08	49.984
1161.00	0.19735350E 06	33898.98	91.165	3026.68	50.444
1166.00	0.19419200E 06	33901.93	90.972	3054.30	50.904
1171.00	0.19160224E 06	33904.34	90.779	3081.91	51.364
1176.00	0.18958325E 06	33906.23	90.586	3109.54	51.825
1181.00	0.18813625E 06	33907.58	90.393	3137.16	52.285
1186.00	0.18726025E 06	33908.40	90.200	3164.78	52.745
1191.00	0.18695600E 06	33908.68	90.012	3191.66	53.193
1196.00	0.18722399E 06	33908.43	90.187	3166.52	52.774
1201.00	0.18806375E 06	33907.65	90.381	3138.91	52.314
1206.00	0.18947500E 06	33906.33	90.574	3111.28	51.854
1211.00	0.19145725E 06	33904.48	90.767	3083.67	51.393
1216.00	0.19401125E 06	33902.10	90.960	3056.05	50.933
1221.00	0.19713575E 06	33899.18	91.153	3028.43	50.473
1226.00	0.20083074E 06	33895.74	91.346	3000.83	50.013
1231.00	0.20509650E 06	33891.76	91.539	2973.23	49.553
1236.00	0.20993149E 06	33887.25	91.732	2945.65	49.093
1241.00	0.21533575E 06	33882.22	91.924	2918.08	48.634
1246.00	0.22130825E 06	33876.65	92.117	2890.53	48.174
1251.00	0.22784799E 06	33870.57	92.309	2862.99	47.715
1256.00	0.23495524E 06	33863.95	92.502	2835.47	47.257
1261.00	0.24262825E 06	33856.82	92.694	2807.97	46.798
1266.00	0.25086650E 06	33849.16	92.886	2780.49	46.340
1271.00	0.25966900E 06	33840.98	93.078	2753.03	45.883
1276.00	0.26903500E 06	33832.28	93.269	2725.59	45.426
1281.00	0.27896275E 06	33823.07	93.461	2698.18	44.969
1286.00	0.28945075E 06	33813.35	93.652	2670.80	44.512
1291.00	0.30049974E 06	33803.11	93.843	2643.44	44.056
1296.00	0.31210600E 06	33792.36	94.034	2616.12	43.601

[redacted]

[redacted]

1301.00	0.32427149E 06	33781.11	94.224	2588.82	43.146
1306.00	0.33699074E 06	33769.35	94.415	2561.55	42.692
1311.00	0.35026424E 06	33757.09	94.605	2534.32	42.238
1316.00	0.36409049E 06	33744.33	94.795	2507.13	41.785
1321.00	0.37846900E 06	33731.08	94.984	2479.97	41.332
1326.00	0.39339600E 06	33717.33	95.173	2452.84	40.880
1331.00	0.40887175E 06	33703.09	95.362	2425.76	40.428
1336.00	0.42489149E 06	33688.37	95.551	2398.72	39.978
1341.00	0.44145650E 06	33673.16	95.739	2371.72	39.528
1346.00	0.45856400E 06	33657.47	95.927	2344.75	39.078
1351.00	0.47621325E 06	33641.30	96.115	2317.84	38.630
1356.00	0.49439950E 06	33624.66	96.302	2290.96	38.182
1361.00	0.51312225E 06	33607.56	96.489	2264.14	37.735
1366.00	0.53238050E 06	33589.98	96.676	2237.36	37.289
1371.00	0.55216949E 06	33571.94	96.862	2210.63	36.843
1376.00	0.57248725E 06	33553.45	97.048	2183.96	36.398
1381.00	0.59333450E 06	33534.50	97.233	2157.33	35.955
1386.00	0.61470824E 06	33515.09	97.418	2130.75	35.512
1391.00	0.63660324E 06	33495.25	97.602	2104.23	35.070
1396.00	0.65902275E 06	33474.95	97.787	2077.76	34.629
1401.00	0.68195625E 06	33454.23	97.970	2051.35	34.188
1406.00	0.70540850E 06	33433.06	98.154	2024.99	33.749
1411.00	0.72937375E 06	33411.47	98.336	1998.70	33.311
1416.00	0.75384799E 06	33389.45	98.519	1972.46	32.874
1421.00	0.77883349E 06	33367.01	98.701	1946.28	32.437
1426.00	0.80432275E 06	33344.16	98.882	1920.16	32.002
1431.00	0.83031549E 06	33320.89	99.063	1894.11	31.568
1436.00	0.85681025E 06	33297.21	99.244	1868.11	31.134
1441.00	0.88380074E 06	33273.13	99.424	1842.18	30.702
1446.00	0.91128924E 06	33248.65	99.603	1816.31	30.271
1451.00	0.93926550E 06	33223.79	99.782	1790.52	29.841
1456.00	0.96773300E 06	33198.53	99.960	1764.79	29.412
1461.00	0.99668725E 06	33172.89	100.138	1739.12	28.985
1466.00	0.10261244E 07	33146.86	100.316	1713.52	28.558
1471.00	0.10560430E 07	33120.47	100.493	1688.00	28.133
1476.00	0.10864379E 07	33093.70	100.669	1662.54	27.708
1481.00	0.11173080E 07	33066.58	100.845	1637.15	27.285
1486.00	0.11486497E 07	33039.09	101.020	1611.84	26.863
1491.00	0.11804615E 07	33011.24	101.194	1586.59	26.443
1496.00	0.12127402E 07	32983.05	101.369	1561.42	26.023
1501.00	0.12454785E 07	32954.51	101.542	1536.33	25.605
1506.00	0.12786772E 07	32925.63	101.715	1511.31	25.188
1511.00	0.13123302E 07	32896.42	101.887	1486.36	24.772
1516.00	0.13464372E 07	32866.88	102.059	1461.49	24.358
1521.00	0.13809945E 07	32837.02	102.230	1436.70	23.944
1526.00	0.14159982E 07	32806.83	102.401	1411.98	23.533
1531.00	0.14514452E 07	32776.33	102.571	1387.35	23.122
1536.00	0.14873355E 07	32745.52	102.740	1362.78	22.713
1541.00	0.15236600E 07	32714.41	102.909	1338.30	22.305
1546.00	0.15604150E 07	32683.00	103.077	1313.91	21.898
1551.00	0.15976080E 07	32651.29	103.245	1289.58	21.493
1556.00	0.16352235E 07	32619.30	103.411	1265.34	21.089
1561.00	0.16732622E 07	32587.02	103.578	1241.19	20.686
1566.00	0.17117237E 07	32554.46	103.743	1217.11	20.285
1571.00	0.17506005E 07	32521.63	103.908	1193.12	19.885
1576.00	0.17898925E 07	32488.53	104.073	1169.20	19.486
1581.00	0.18295957E 07	32455.17	104.236	1145.37	19.089
1586.00	0.18697087E 07	32421.54	104.399	1121.63	18.693

1591.00	0.19102212E 07	32387.67	104.562	1097.97	18.299
1596.00	0.19511385E 07	32353.54	104.724	1074.39	17.906
1601.00	0.19924497E 07	32319.17	104.885	1050.90	17.515
1606.00	0.20341574E 07	32284.56	105.045	1027.49	17.124
1611.00	0.20762512E 07	32249.72	105.205	1004.17	16.736
1616.00	0.21187397E 07	32214.65	105.364	980.93	16.348
1621.00	0.21616054E 07	32179.35	105.523	957.78	15.963
1626.00	0.22048572E 07	32143.83	105.680	934.72	15.578
1631.00	0.22484797E 07	32108.10	105.838	911.74	15.195
1636.00	0.22924770E 07	32072.16	105.994	888.85	14.814
1641.00	0.23368464E 07	32036.02	106.150	866.05	14.434
1646.00	0.23815829E 07	31999.67	106.305	843.33	14.055
1651.00	0.24266895E 07	31963.12	106.459	820.70	13.678
1656.00	0.24721479E 07	31926.39	106.613	798.16	13.302
1661.00	0.25179642E 07	31889.47	106.766	775.70	12.928
1666.00	0.25641355E 07	31852.37	106.919	753.34	12.555
1671.00	0.26106577E 07	31815.08	107.070	731.06	12.184
1676.00	0.26575267E 07	31777.63	107.221	708.87	11.814
1681.00	0.27047387E 07	31740.01	107.372	686.77	11.446
1686.00	0.27522915E 07	31702.22	107.521	664.76	11.079
1691.00	0.28001832E 07	31664.27	107.670	642.84	10.714
1696.00	0.28484057E 07	31626.17	107.819	621.00	10.350
1701.00	0.28969610E 07	31587.91	107.966	599.25	9.987
1706.00	0.29458389E 07	31549.52	108.113	577.60	9.626
1711.00	0.29950432E 07	31510.97	108.260	556.03	9.267
1716.00	0.30445712E 07	31472.29	108.405	534.55	8.909
1721.00	0.30944112E 07	31433.47	108.550	513.16	8.552
1726.00	0.31445662E 07	31394.53	108.694	491.86	8.197
1731.00	0.31950352E 07	31355.45	108.838	470.65	7.844
1736.00	0.32458117E 07	31316.26	108.981	449.52	7.492
1741.00	0.32968874E 07	31276.95	109.123	428.49	7.141
1746.00	0.33482715E 07	31237.52	109.264	407.54	6.792
1751.00	0.33999465E 07	31197.98	109.405	386.69	6.445
1756.00	0.34519230E 07	31158.33	109.545	365.92	6.099
1761.00	0.35041880E 07	31118.59	109.685	345.24	5.754
1766.00	0.35567389E 07	31078.74	109.823	324.65	5.411
1771.00	0.36095812E 07	31038.80	109.961	304.15	5.069
1776.00	0.36627062E 07	30998.76	110.099	283.73	4.729
1781.00	0.37161002E 07	30958.64	110.235	263.41	4.390
1786.00	0.37697820E 07	30918.43	110.371	243.17	4.053
1791.00	0.38237317E 07	30878.15	110.507	223.02	3.717
1796.00	0.38779547E 07	30837.78	110.641	202.96	3.383
1801.00	0.39324417E 07	30797.34	110.775	182.98	3.050
1806.00	0.39871937E 07	30756.83	110.909	163.10	2.718
1811.00	0.40422034E 07	30716.25	111.041	143.30	2.388
1816.00	0.40974750E 07	30675.61	111.173	123.59	2.060
1821.00	0.41530005E 07	30634.91	111.305	103.97	1.733
1826.00	0.42087802E 07	30594.14	111.435	84.43	1.407
1831.00	0.42648060E 07	30553.33	111.565	64.98	1.083
1836.00	0.43210837E 07	30512.46	111.695	45.62	0.760
1841.00	0.43775972E 07	30471.54	111.823	26.34	0.439
1846.00	0.44343577E 07	30430.58	111.951	7.15	0.119
1851.00	0.44913545E 07	30389.58	112.079	-11.96	-0.199
1856.00	0.45485827E 07	30348.53	112.205	-30.97	-0.516
1861.00	0.46060497E 07	30307.45	112.331	-49.91	-0.832
1866.00	0.46637399E 07	30266.34	112.457	-68.76	-1.146
1871.00	0.47216630E 07	30225.19	112.581	-87.52	-1.459
1876.00	0.47798029E 07	30184.02	112.706	-106.20	-1.770

1881.00	0.48381707E 07	30142.82	112.829	-124.79	-2.080
1886.00	0.48967532E 07	30101.59	112.952	-143.30	-2.388
1891.00	0.49555489E 07	30060.35	113.074	-161.73	-2.695
1896.00	0.50145642E 07	30019.09	113.195	-180.07	-3.001
1901.00	0.50737852E 07	29977.81	113.316	-198.33	-3.305
1906.00	0.51332170E 07	29936.52	113.436	-216.50	-3.608
1911.00	0.51928545E 07	29895.22	113.556	-234.60	-3.910
1916.00	0.52526917E 07	29853.91	113.675	-252.61	-4.210
1921.00	0.53127297E 07	29812.60	113.793	-270.53	-4.509
1926.00	0.53729707E 07	29771.27	113.911	-288.38	-4.806
1931.00	0.54334007E 07	29729.96	114.028	-306.14	-5.102
1936.00	0.54940222E 07	29688.64	114.144	-323.82	-5.397
1941.00	0.55548392E 07	29647.32	114.260	-341.43	-5.690
1946.00	0.56158340E 07	29606.02	114.376	-358.94	-5.982
1951.00	0.56770210E 07	29564.72	114.490	-376.38	-6.273
1956.00	0.57383925E 07	29523.42	114.604	-393.74	-6.562
1961.00	0.57999454E 07	29482.14	114.717	-411.02	-6.850
1966.00	0.58616690E 07	29440.87	114.830	-428.22	-7.137
1971.00	0.59235742E 07	29399.62	114.942	-445.34	-7.422
1976.00	0.59856535E 07	29358.39	115.054	-462.39	-7.706
1981.00	0.60478977E 07	29317.17	115.165	-479.35	-7.989
1986.00	0.61103162E 07	29275.98	115.275	-496.23	-8.270
1991.00	0.61728952E 07	29234.81	115.385	-513.04	-8.550
1996.00	0.62356317E 07	29193.67	115.494	-529.77	-8.829
2001.00	0.62985522E 07	29152.54	115.603	-546.42	-9.107
2006.00	0.63616197E 07	29111.45	115.711	-563.00	-9.383
2011.00	0.64248462E 07	29070.39	115.818	-579.49	-9.658
2016.00	0.64882137E 07	29029.37	115.925	-595.91	-9.932
2021.00	0.65517475E 07	28988.37	116.031	-612.26	-10.204
2026.00	0.66154350E 07	28947.41	116.137	-628.53	-10.475
2031.00	0.66792785E 07	28906.48	116.242	-644.73	-10.745
2036.00	0.67432467E 07	28865.60	116.347	-660.84	-11.014

ORBIT ACHEIVED

SEMI-MAJOR AXIS=7.604119E 07 FEET= 12506.219 NAUTICAL MILES
ECCENTRICITY= 0.722652
TIME OF PERIOD= 35115.94 SECONDS

TRAJECTORY CUTOFF VALUES

STAGE	ALTITUDE	VELOCITY	GAMMA	THETA	PERIOD
1	1.53789249E 05	0.51458510E 04	0.53416225E 02	0.34634720E-00	0.
2	9.41007245E 05	0.18998109E 05	0.87150615E 02	0.11364605E 02	0.
3	4.59665996E 05	0.33656459E 05	0.95939068E 02	0.39049923E 02	0.35115940E 05

MISSILE VELOCITY CHARACTERISTICS

STAGE	V GRAVITY LOSS	V DRAG LOSS	V ATTACK LOSS	IDEAL VELOCITY	V INCREASE	PERCENT IDEAL V
1	3656.46	292.00	0.	9094.31	5145.85	56.58
2	3667.97	0.	2092.04	19612.27	13852.26	70.63
3	-489.29	0.	688.77	14857.83	14658.35	98.66

FLIGHT	6835.13	292.00	2780.81	43564.41	33656.46	77.26

FLIGHT MAXIMUM DYNAMIC PRESSURE= 621.35

[redacted]

[redacted]