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POSTFLIGHT TRAJECTORY REASSEMBLY

AC-6

GDC-BTD66-012
18 February 1966

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POSTFLIGHT TRAJECTORY REASSEMBLY

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Contract NAS3-3232

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FOREWORD

This report presents the results of a postflight trajectory reassembly of Atlas/Centaur flight AC-6. AC-6 was launched from the Eastern Test Range, Complex 36B, at 0931 hours EST on 11 August 1965.

The reassembly analysis is confined primarily to those systems and parameters having major influence on trajectory design and on payload capability. The analysis and documentation was performed in compliance with Item 129 of the Centaur Documentation Requirements Plan, Contract NAS3-3232.

SUMMARY

This report presents the results of a trajectory reassembly of Atlas/Centaur flight AC-6. The reassembly covers the portion of flight from liftoff through Centaur retro-maneuver. The reassembly is based on perturbing vehicle systems parameters in a detailed trajectory simulation to effect a close match of flight-measured position and velocity data throughout the simulation. The ultimate purpose of these data is to establish accurately the vehicle performance capability and to improve the accuracy of the trajectory design for succeeding vehicles. The analysis stresses those systems that have the greatest effect on trajectory design and payload capability.

It is emphasized that this flight is only one in a series, and the data obtained are only a fraction of that required for statistical evaluation of net vehicle performance capability.

Net Atlas/Centaur performance was better than predicted. This was the result of better-than-nominal Atlas-stage performance (but less-than-nominal Centaur-stage performance). Surveyor mission payload capability, calculated using flight-determined residuals, is 20 pounds greater than the predicted mean payload capability (see Section 7.1).

The Atlas-stage trajectory was higher and faster than the preflight-predicted. This was due primarily to higher-than-nominal booster and sustainer thrust, and lower-than-predicted booster phase drag. Booster and sustainer engine thrusts were 1100 and 1450 pounds greater than predicted, respectively.

A revised Atlas drag model (Section 7.6) was incorporated in the AC-6 reassembly in order to better simulate the booster phase drag. This model (similar to the AC-4 reassembly drag model) has been adopted for use in current Atlas/Centaur preflight simulations. In this model, the booster phase base force has been revised based on flight data and separated into two components. One component is a function of dynamic pressure and the other is a function of ambient pressure ratio. The forebody drag coefficient is the same as that previously used. Also considered part of the revised drag model is a holddown force that is simulated during the first few seconds after liftoff.

Centaur-stage performance was less than nominal. At Centaur main engine cutoff, the vehicle was low and slow, compared to the preflight trajectory, even though Atlas performance was better than nominal and Centaur burn time was longer than nominal. Centaur main engine thrust was 499 pounds low. Centaur main engine specific impulse was 1.3 seconds low.

The vehicle system parameters determined from the AC-6 reassembly are summarized in Table A. Vehicle system parameters used in the preflight simulation and engine log values are shown for comparison.

Spacecraft and Centaur-tank orbit data are summarized in Table B. No flight data for the Centaur tank orbit were available. Separation distance between the spacecraft and tank five hours after spacecraft separation from Centaur, as determined from the reassembly, was 1966 km.

Table A. Atlas/Centaur System Parameters

PARAMETER	PREFLIGHT SIMULATION	LOG OR ENGINE ACCEPTANCE VALUES	REASSEMBLY	DEVIATION (REASSEMBLY MINUS PREFLIGHT SIMULATION)	PREDICTED 3σ DISPERSION
Atlas Propulsion (Altitude Reference Conditions)					
Booster Thrust (lb)	375,804	374,207	376,910	+1,106	$\pm 3,000$
Booster I_{sp} (sec)	289.91	289.52	287.44	-2.47	± 2.4
Booster Mixture Ratio ($LO_2/RP-1$)	2.278	2.290	2.264	-0.014	± 0.023
(Sea Level Reference Conditions)					
Sustainer Thrust (lb)	57,000	57,000	58,449	+1,449	± 855
Sustainer Plus Vernier I_{sp} (sec)	214.41	213.2	218.52	+4.1	± 2.8
Sustainer Plus Vernier Mixture Ratio ($LO_2/RP-1$)	2.27	2.27	2.27	0	Not Available
Atlas Autopilot					
Booster Pitch Factor	1.000	--	1.014	+0.014	± 0.050
Booster Roll (deg)	20.461	--	20.193	-0.268	± 2.0
Centaur Propulsion (Altitude Reference Conditions)					
Main Engines Thrust, Total (lb)	30,024	29,893	29,525	-499	± 424
I_{sp} (sec)	432.93	434.78	431.6	-1.3	± 3.54
Mixture Ratio (LO_2/LH_2)	4.968/1	5.016	--	0	$\pm 2\%$

Table B. Orbit Data

PARAMETER	CENTAUR TANK		SPACECRAFT		
	PREFLIGHT ⁽¹⁾	REASSEMBLY ⁽¹⁾	PREFLIGHT ⁽²⁾	REASSEMBLY ⁽²⁾	FLIGHT ⁽²⁾⁽³⁾
Semimajor Axis (ft)	1,426,599,100	1,358,208,800	1,400,061,300	1,334,602,400	1,363,201,800
Eccentricity	0.98494887	0.98419073	0.98466136	0.98391106	0.98424758
Inclination (deg)	28.595885	28.559768	28.593421	28.557672	28.562167
Longitude of Ascending Node (deg)	358.92263	359.10143	358.92263	359.10143	359.08078
Argument of Perigee (deg)	131.04756	131.02614	131.03417	131.01514	131.00263
True Anomaly (deg)	0.93960006	0.79304000	-6.11391	-5.79552	-5.7576991
(1) Data epoch is end of Centaur retromaneuver					
(2) Data epoch is end of Centaur main engine decay					
(3) JPL orbit determination from S-band radar data					

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SECTION 1

INTRODUCTION

This report presents the results of a trajectory reassembly of Atlas/Centaur flight AC-6. A trajectory reassembly is defined as a digital trajectory simulation for the flight vehicle which closely matches measured flight data. The purpose of such an analysis is to provide:

- a. Statistical data for evaluation of net vehicle performance capability.
- b. Comparison data to correct preflight simulation techniques or to indicate erroneous flight test data.
- c. An alternate technique for determining system and vehicle performance.
- d. Estimates of unmeasured trajectory parameters.

The Convair "COMBO Flight Program", Reference 1, is used to simulate Atlas/Centaur preflight and reassembly trajectories. COMBO is a general-purpose program to simulate the flight of a vehicle either powered or unpowered in the gravitational field of a central body. As used for vehicle AC-6, the program simulates a rotating oblate-earth model (up to and including the fourth harmonic), detailed Atlas propulsion, detailed Centaur guidance, and numerous other mission, vehicle, and flight system parameters as presented in References 2 and 3.

The trajectory reassembly of vehicle AC-6 used the PFAN-II program, Reference 4, in conjunction with COMBO to match closely the Best Estimate of Trajectory (BET) position and velocity generated by the Eastern Test Range. The PFAN-II program provides a least-squares match of trajectory parameters at various time points throughout a given phase of the vehicle flight by adjusting vehicle system parameters such as thrust, flow rate, and the pitch multiplication factor.

The AC-6 vehicle includes most of the system configurations associated with the operational Atlas/Centaur. The flight was designed to simulate the launch-time-dependent aspects of an operational Surveyor direct-ascent mission, and the ascent trajectory was targeted for lunar impact. However, the launch was restricted to daylight hours and launch times biased to preclude lunar encounter. Salient configuration changes between the AC-6 vehicle and previous Atlas/Centaur vehicles are

1. Change to the Centaur RL10A-3-1 engine system from the RL10A-3.
2. Incorporation of a propellant utilization system on the Centaur stage.

3. Atlas booster engines uprated to 165,000 pounds of thrust each from 154,500 pounds.
4. Atlas sustainer engine cutoff by propellant depletion instead of timed cutoff.

Trajectory reassemblies have also been performed for Atlas/Centaur flights AC-2, AC-3, and AC-4. As a result of these reassemblies and analyses connected with these reassemblies, the preflight simulation model has been revised to incorporate an improved Atlas drag model and to simulate Centaur thrust buildup. In addition, due to the lack of tracking data during re-entry, the AC-3 reassembly provided the only estimate of the re-entry phase. Also due to a lack of tracking data, the AC-6 reassembly provides the best estimate of the Centaur orbit after retromaneuver and hence of spacecraft separation from Centaur.

SECTION 2

PREFLIGHT TRAJECTORY

The preflight simulation used for a comparison is the best preflight simulation of the actual trajectory. It includes all information that can be determined from data measured prior to the flight, even though the analysis of that data might occur subsequent to the flight. The best preflight simulation will always include, when available, launch day atmospheric data (winds, pressure, and speed of sound) and launch day weights (which account for last-minute hardware changes and analysis of propellant loading data).

Nominal Centaur main engine thrust buildup, developed over a period of approximately 2 seconds, was also simulated in the best preflight simulation for AC-6. Data on the nominal buildup is presented in Reference 5. Preflight simulations, prior to the January 1966 issue of Reference 3, have not included the thrust buildup since it has very little effect on payload capability as determined by a simulation with cutoff by energy. However, the cutoff time determined in this manner is one second early, and in a reassembly, which stages by time (required to match flight-measured times), omission of the thrust buildup causes a significant error in the reassembly value of main engine specific impulse.

The deviation of the Centaur main engines from equilibrium thrust during the first approximately 90 seconds of main engine firing was not simulated in the AC-6 best preflight trajectory. The reason this phenomenon was not simulated is due to the small nominal deviation predicted for the RL10A-3-1 engines, Reference 5. However, results of the reassembly analysis indicate that there was a deviation on this flight with a significant effect on the reassembly (see Section 7.4.2).

Figure 2-1 presents a comparison of the best preflight trajectory and the flight trajectory as defined by the range-derived BET. Differences between the BET and the best preflight inertial components of position and velocity are shown for the U, V, and W axes.

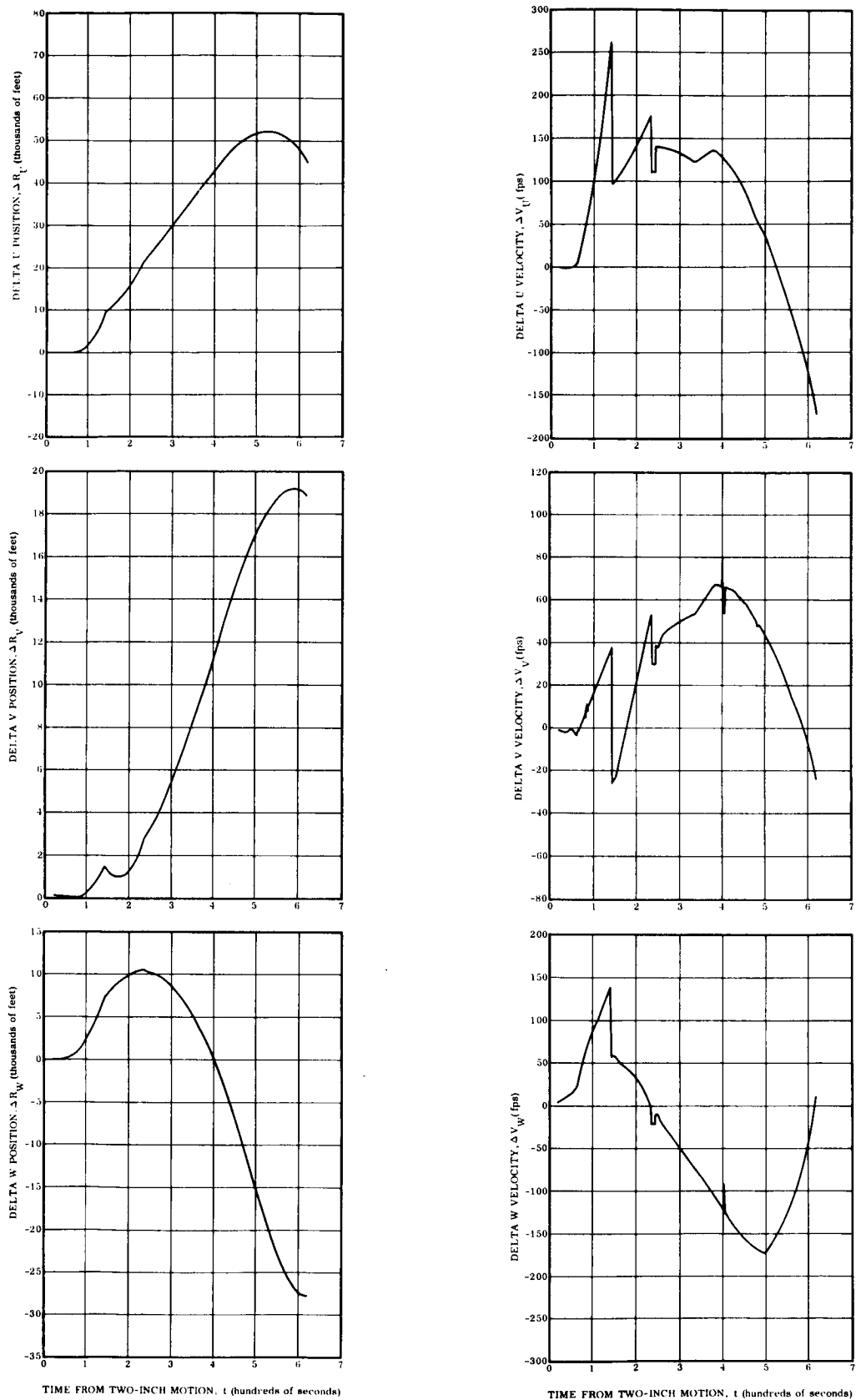


Figure 2-1. Preflight Minus BET Trajectory Data

SECTION 3

METHOD OF ANALYSIS

The starting point for the reassembly is a predicted - or reference-trajectory simulation. The predicted trajectory, including all accurately known vehicle and flight data, is termed the Modified Preflight Trajectory (see Section 5). Any such trajectory is a function of the vehicle and system parameters (control variables) such as thrust, flow rate, and pitch multiplication factor. In order to obtain a reassembly trajectory it is necessary to find modified control variables such that the resulting trajectory closely matches measured flight data.

In general, if a set of m trajectory components are to be matched to flight data at r different times along the trajectory, a total of $m \times r$ vehicle parameters must be adjusted. If the m trajectory components are to be matched in a least-squares sense at r different times along the trajectory, at least m vehicle parameters (but not exceeding $m \times r$) must be adjusted. Intuitively, deviations (bias or percentage) in vehicle system parameters for a stage are expected to be constants rather than functions of time. If the deviations are a function of time within a given stage, it is a good indication that the analytical model being used for some system in that stage is inadequate. In this case the proper solution is to correct the analytical model. It is not realistic to change the values of the same vehicle parameters in a discontinuous manner over successive time increments. Thus, the trajectory should be matched in flight phases corresponding to those during which a particular vehicle or system is operating.

Within a given stage for which a reassembly is being attempted, it is desirable to use as many data points for the match as practical. The data points should be matched in the reassembly in a manner to eliminate or reduce the effects of errors in the data points. A solution is to seek the best fit, in a least squares sense, over a given stage. The PFAN-II program developed at Convair for use with the COMBO Flight Program provides the required solution. This program forces the COMBO trajectory simulation to match measured flight data, in a least squares sense, at discrete time points throughout the flight. The mathematical basis of the PFAN-II Program is presented in Reference 4.

The AC-6 trajectory reassembly, generated by using the PFAN-II and COMBO Flight Programs, varied certain vehicle parameters to match, in a least squares sense, the position and velocity data (three components for each) at 29 time points throughout the flight and match fuel and oxidizer residuals at sustainer engine cutoff. The 29 time points consisted of 15 match points in the Atlas stage and 14 match points in the Centaur stage. The flight data for the match were the Best Estimate of Trajectory (BET) data generated by the Eastern Test Range (see Section 4).

The particular control variables, time points, and match variables used for the AC-6 reassembly are:

a. Atlas Stage

1. Control Variables

- (a) Booster Thrust Multiplier
- (b) Booster Fuel Flow Rate Multiplier
- (c) Booster Oxidizer Flow Rate Multiplier
- (d) Sustainer Thrust Multiplier
- (e) Sustainer Fuel and Oxidizer Flow Rate Multiplier
- (f) Booster Phase Pitch Program Multiplier
- (g) Booster Phase Pitch Drift
- (h) Booster Phase Yaw Drift
- (i) Booster Phase Roll Program Multiplier
- (j) Sustainer Phase Initial Pitch Attitude
- (k) Sustainer Phase Initial Yaw Attitude
- (l) Sustainer Phase Pitch Drift
- (m) Sustainer Phase Yaw Drift
- (n) Booster Engine Begin Decay Time
- (o) Launch Mechanism Holddown Force

2. Match Variables

- (a) at $t = 40, 70, 100, 110, 120, 130, 138, 160, 170, 180, 190, 200, 210, 220,$ and 230 Seconds.
 Position (R_U, R_V, R_W)
 Velocity (V_U, V_V, V_W)
- (b) at $t = 226.7$ (Fuel Port Uncovery)
 $W_F = 887 \text{ lb}$
- (c) at $t = 227$ (LO_2 Port Uncovery)
 $W_O = 1823 \text{ lb}$

b. Centaur Stage

1. Control Variables

- (a) Pitch Drift During Main Engine Firing
- (b) Yaw Drift During Main Engine Firing
- (c) Initial Pitch Attitude at Main Engine Start
- (d) Initial Yaw Attitude at Main Engine Start
- (e) Initial Pitch Attitude at Admit Guidance Perigee Altitude Control
- (f) Centaur Main Engine Thrust
- (g) Centaur Main Engine Fuel and Oxidizer Flow Rate

2. Match Variables

at $t = 250, 280, 310, 340, 370, 430, 460, 490, 520, 550, 580, 610, 640,$ and
670 Seconds.

Position (R_U, R_V, R_W)

Velocity (V_U, V_V, V_W)

SECTION 4

FLIGHT TRAJECTORY DATA

The quality of a trajectory reassembly depends on the type and accuracy of the flight trajectory data that are matched and the technique used. The primary flight trajectory data used for the AC-6 trajectory reassembly were the inertial position and velocity data of the range-supplied Best Estimate Trajectory (BET). These data, revised to account for a re-survey of the Bermuda Glotrac, were received 123 days after the flight.

The Guidance Estimate of Trajectory (GET) position and velocity data, although used for the AC-4 trajectory reassembly, were not used in the AC-6 trajectory reassembly. The GET data are inherently smooth and, for this flight, continuous from liftoff to well past Centaur main engine cutoff. In addition, the GET was available 8 days after launch. However, comparison of these data with the original range BET showed a considerable error between GET and BET data. Inclusion of the Bermuda-site re-survey data reduced this error, but the remaining error is significant: 5000 feet position and 18 ft/sec velocity errors in the inertial W components at 620 seconds. The differences between the two sources as a function of time are shown in Table 4-1. The differences between the BET and GET data are considered to be primarily due to errors in the GET data. The close agreement of the reassembly (BET match data) injection conditions with Jet Propulsion Laboratory orbit data (from S-band radar data) seems to support this contention. (See Section 6.)

Table 4-1. Range Best Estimate Trajectory Minus
Guidance Estimated Trajectory

TIME (sec)	ΔR_U (ft)	ΔR_V (ft)	ΔR_W (ft)	ΔV_U (fps)	ΔV_V (fps)	ΔV_W (fps)
40	-8	149	-17	-0.0595	-0.0355	-0.0859
60	7	177	-38	-0.2033	0.3528	-0.6521
70	2	171	-38	-0.2908	0.8282	-0.7049
80	1	171	-58	-0.6039	1.0151	-0.7740
90	0	192	-66	-0.1833	0.6326	-1.0148
100	-1	215	-81	0.4034	0.4308	-1.9651
110	13	206	-133	0.1724	0.2714	-2.3970
120	8	222	-149	0.3531	0.4013	-3.4686
130	-3	231	-162	-0.2339	0.5953	-4.2052
138	-5	241	-216	-0.4030	1.0938	-5.4075
150	-8	256	-294	-0.1728	0.5591	-6.5312
160	-15	228	-343	-0.6459	0.9572	-6.3090
170	-26	254	-396	-0.6423	1.1601	-6.6365

Table 4-1. Range Best Estimate Trajectory Minus
Guidance Estimated Trajectory (Contd.)

TIME (sec)	ΔR_U (ft)	ΔR_V (ft)	ΔR_W (ft)	ΔV_U (fps)	ΔV_V (fps)	ΔV_W (fps)
180	-40	262	460	0.558	1.3183	6.8157
190	-73	284	-546	-0.808	1.3720	-6.9199
200	-42	295	-610	-1.208	0.4795	-6.3259
210	-42	300	-699	-1.309	1.3454	-7.0463
220	-61	307	-767	-1.371	1.2249	-7.4477
240	-67	330	-914	-1.352	1.2460	-8.0326
260	-128	364	-1058	-1.723	1.5050	-7.9040
280	-182	397	-1214	-1.990	1.4384	-7.9249
300	-253	415	-1382	-2.363	1.3480	-8.5699
320	-223	446	-1560	-2.486	1.5817	-8.3784
340	-295	481	-1749	-2.772	1.5455	-8.7215
360	-376	503	-1858	-3.139	1.6604	-8.9999
380	-478	538	-2056	-3.447	1.4567	-9.1518
400	-501	451	-1983	-4.524	13.7665	-38.0585
420	-572	604	-2479	-4.165	1.7954	-10.3972
440	-682	649	-2630	-4.404	1.7407	-10.4815
460	-805	676	-2861	-4.685	1.5207	-11.0069
480	-909	701	-3096	-5.457	0.5804	-12.3666
500	-996	724	-3327	-5.422	1.4604	-11.8996
520	-1081	806	-3593	-5.755	1.5185	-12.5539
540	-1171	796	-3821	-6.322	1.3580	-13.1311
560	-1369	838	-4084	-6.825	0.9958	-14.0238
580	-1472	825	-4399	-7.522	0.7670	-15.2914
600	-1681	875	-4710	-8.378	0.4585	-16.944
620	-1780	857	-5029	-8.626	-0.2016	-18.033

The range-supplied BET data were usable for the purposes of this analysis from 40 seconds after liftoff to 620 seconds after liftoff. Quality of the data in this time interval is good when the obviously erroneous points around 400 seconds of flight (Azusa-to-Bermuda handover) are eliminated. As in the AC-4 BET data, there is a bias shift in the W component of the GET-minus-BET deltas at data handover. However, the bias for this flight is less than 1/4 ft/sec. Further information concerning the quality of the data may be obtained from Reference 6.

In order to obtain reasonably accurate injection conditions for the reassembly, it was necessary to have data for the period of flight from 620 seconds of flight to Centaur main engine cutoff. This was accomplished by extrapolating the BET-GET deltas to cover the required time interval and applying these deltas to the relatively smooth and continuous GET data.

Additional flight trajectory data matched in the reassembly are Atlas fuel and LO₂ weights above the pump inlets at fuel and LO₂ port uncover times. The method of calculating these Atlas propellant weights is presented in Reference 7.

SECTION 5

MODIFIED PREFLIGHT TRAJECTORY

The modified preflight trajectory is the basic reference trajectory simulation from which the reassembly is initiated. It is a modification of the preflight trajectory (Section 2) to include flight measured data. The data may be based on analyses conducted prior to and/or subsequent to the flight. The following data, based on flight measurements, were used in the modified preflight trajectory.

- a. Atmospheric Data (Rawinsonde balloon released 9 minutes after liftoff)
 - 1. Wind speed and direction as a function of altitude
 - 2. Density as a function of altitude
 - 3. Ambient pressure as a function of altitude
 - 4. Temperature as a function of altitude
- b. Propulsion Data
 - 1. Atlas PU valve position (telemetry)
 - 2. Atlas liquid oxygen and fuel tank ullage pressures (telemetry)
 - 3. Atlas liquid oxygen and fuel density (calculated from telemetered measurements)
 - 4. Centaur main engine thrust buildup (calculated from telemetered chamber-pressure measurements with modifications based on accelerometer data)
- c. Weight Data
 - 1. Hardware (weighings and calculations)
 - 2. Propellants (calculated from density and volume measurements)
- d. Sequence of Events Data from Reference 7 (primarily based on CM101A accelerometer readings)
- e. Aerodynamic Data (See Section 7.6)
 - 1. Booster phase drag
 - 2. Booster phase base thrust
- f. Atlas-sustainer and Centaur pitch rate history data (calculated from guidance computer telemetered thrust-velocity data)

SECTION 6

COMPARISON OF REASSEMBLY TRAJECTORY WITH FLIGHT DATA

Delta position and velocity components between the AC-6 trajectory reassembly and range BET computed every second from liftoff are shown in Figure 6-1. The magnitude and distribution of these position and velocity deltas indicate how well the computed trajectory duplicates the actual flight. The reassembly is considered satisfactory if the deltas are small and apparently random. A systematic pattern of these deltas, assuming error-free tracking data, would indicate a deficiency in one or more of the mathematical models used in the simulation or some unaccounted-for deviation in vehicle performance. The maximum position error, excluding the extreme deltas caused by noisy BET data at handover and after 620 seconds of flight, is 265 feet in the U-axis direction. The maximum velocity delta is 7 ft/sec in the W-axis direction, when the deltas in the U component at 143 seconds and in the W component at 142 seconds, as well as those extreme deltas caused by noisy BET data, are excluded. The BET points at 142 and 143 seconds are in error because a linear interpolation technique was used to adjust the BET data to even one-second time increments relative to two-inch motion.

During the Atlas phase, the maximum position residual is less than that for the AC-4 reassembly. This is attributed to the addition of yaw drift as a control variable during the booster engine phase of the AC-6 reassembly. The maximum velocity residual during the Atlas phase is slightly larger (1 ft/sec) than for the AC-4 reassembly. The magnitude of these errors is acceptable; however, a definite trend exists in both the AC-4 and AC-6 deltas at booster staging. This error is largely due to an error in the preflight thrust-decay model, which was also used in the reassembly simulation. Analysis of AC-2 through AC-6 begin-booster-engine-thrust-decay times determined from CM101A accelerometer data (References 7 through 10) yields a mean delay in start-decay-time-from-BECO discrete of 0.145 seconds with a standard deviation of 0.01 seconds. Because of this, booster engine stage time was used as a reassembly control variable. This technique was also used in the analysis of Reference 11. As may be seen from the AC-6 velocity deltas, use of stage time as a control variable did not satisfactorily eliminate the error. Actual booster thrust decay and that obtained using stage time as a control variable are compared in Section 7.4.1

The AC-6 deltas during the Centaur phase of flight are much larger than those for the AC-4 reassembly. The systematic pattern and the increase in the magnitude of the deltas during the Centaur stage is primarily due to complications in the propulsion simulation caused by incorporation of the propellant utilization system in AC-6. Centaur-stage propulsion simulation is discussed in detail in Section 7.4.2.

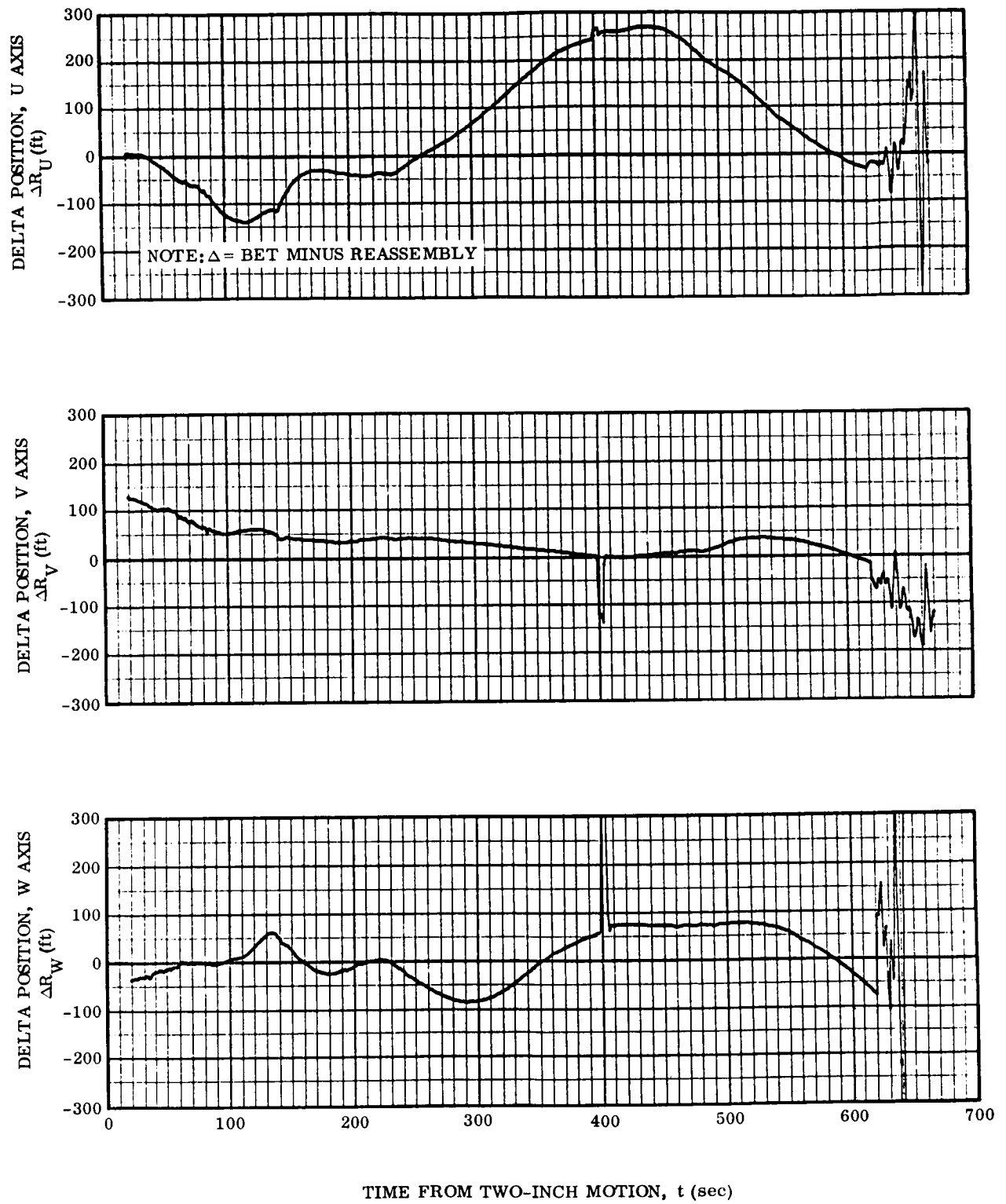


Figure 6-1. Delta Position and Velocity Along the U, V, and W Axes (sheet 1 of 2)

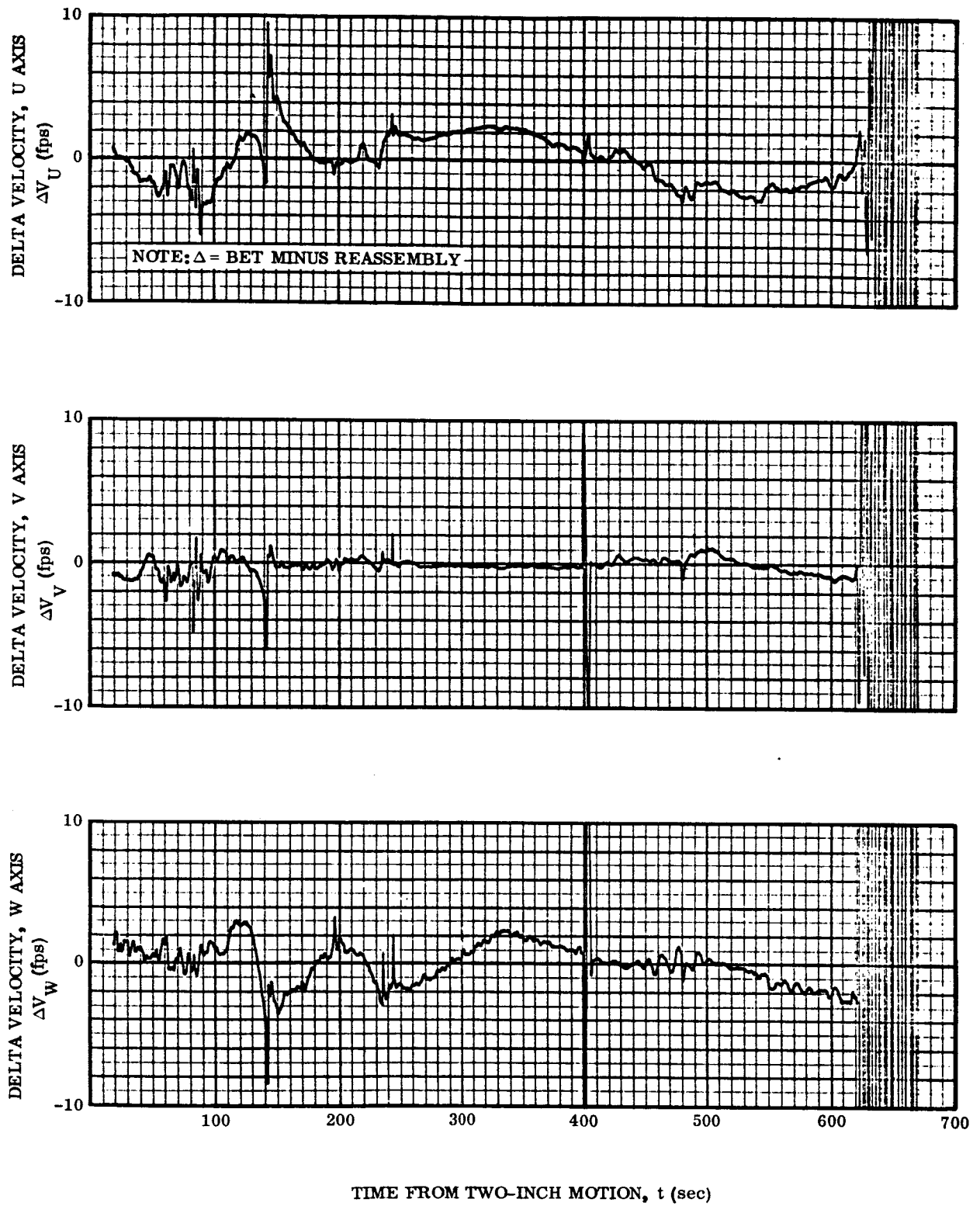


Figure 6-1. Delta Position and Velocity Along the U, V, and W Axes (sheet 2 of 2)

Spacecraft orbital data from the reassembly are compared in Table 6-1 to that determined by the Jet Propulsion Laboratory from S-band radar data (Reference 12). A 3/4 ft/sec velocity increment (provided by the separation springs) is inherent in the JPL orbit data since the acquisition spans of the data used for the orbit determination occur after separation. The epoch for the orbit data (JPL and reassembly), however, is prior to actual separation. Since the separation velocity increment is not simulated in the reassembly until time of separation, this increment is not in the reassembly orbit data. When this increment is added to the orbital velocity for the reassembly the comparison is good.

Table 6-1. AC-6 Spacecraft Orbital Parameters

PARAMETER	PREFLIGHT	FLIGHT	REASSEMBLY
Radius (ft)	21,535,809	21,527,589	21,526,912
Latitude (deg)	23.1052	22.983811	22.9879
Longitude (deg)	307.0162	307.44802	307.4468
Earth Relative Velocity (fps)	34,642.653	34,645.656	34,643.325
Pitch Angle (deg)	-3.15375	-2.9693615	-2.98837
Azimuth (deg)	108.041	108.15662	108.143
Semimajor Axis (ft)	1,400,061,300	1,363,201,800	1,334,602,400
Eccentricity	0.98466136	0.98424758	0.98391106
Inclination (deg)	28.593421	28.562167	28.557672
C_3 (ft ² /sec ²)	-10,054,192	-10,326,042	-10,547,312
Longitude of Ascending Node (deg)	358.92263	359.08078	359.10143
Argument of Perigee (deg)	131.03417	131.00263	131.01514
True Anomaly (deg)	-6.11391	-5.7576991	-5.79552

Note: Data epoch is end of Centaur main engine decay.

SECTION 7

REASSEMBLY RESULTS

The following subsections present the major results of the vehicle AC-6 trajectory reassembly. These results are compared to the preflight trajectory simulation, Section 2, and where possible, to flight-measured values.

7.1 PAYLOAD CAPABILITY. Mission objectives are satisfied by a launch vehicle when a specified payload weight is injected into a required orbit. Payload capability is a measure of a launch vehicle's weight-delivery capability in performing a desired mission. The predicted payload capability of a given launch vehicle is necessarily a function of the required orbit and the amount of propellants held in reserve to statistically ensure achievement of the required orbit. In equation form, predicted payload capability weight (W_{PC}) is

$$W_{PC} = W_{BO} - W_{FPR} - W_{JETT} \quad (1)$$

where

W_{BO} is the nominal burnout weight injected into the required orbit by Atlas/Centaur, assuming that all systems function according to the predicted mean on a normal distribution curve.

W_{FPR} is the amount of Centaur stage propellants held in reserve to ensure a 3-sigma (99.87 percent) probability of achieving the required injection energy.

W_{JETT} is the separated Centaur-stage weight at the time of Centaur-stage burnout.

For most efficient use of the launch vehicle, the separated spacecraft weight should equal the predicted payload capability. However, Surveyor mission payload capability for a direct-ascent vehicle, such as AC-6, is a function of launch time. Thus, at most launch times during a launch window a performance margin will exist. This margin consists of Centaur propellants in excess of the performance reserve. A margin will occur whenever the predicted payload capability is greater than the actual spacecraft weight.

The preflight-predicted capability for AC-6, from Equation 1, was 2100 pounds based on

- a. $W_{BO} = 6424$ pounds (see Appendix A).
- b. $W_{FPR} = 180$ pounds (includes a 20-pound margin to account for the probable error in FPR due to the use of idealized guidance simulation for FPR determination).
- c. $W_{JETT} = 4144$ pounds (including a propellant-utilization bias of 60 pounds of LH_2 , Reference 3).

The AC-6 spacecraft weight was 2084 pounds resulting in a net margin of 16 pounds. The payload capability, assuming that all systems functioned according to the predicted mean on a normal distribution curve (50% probability), was 2280 pounds (2100 + 180). This statistical treatment of payload capability is illustrated in Figure 7-1.

Postflight payload capability is the weight of functional payload that the vehicle (operating as it did on the flight) could have injected into the required orbit. Each pound of propellant residual at burnout in excess of trapped, gaseous, and propellant-utilization-system LH_2 bias is equivalent to a pound of payload, since the vehicle could have been tanked light by an amount equal to the excess propellant residual and the payload increased the same amount (the same liftoff weight is maintained). With the above definitions, postflight payload capability can be expressed as in Equation 2.

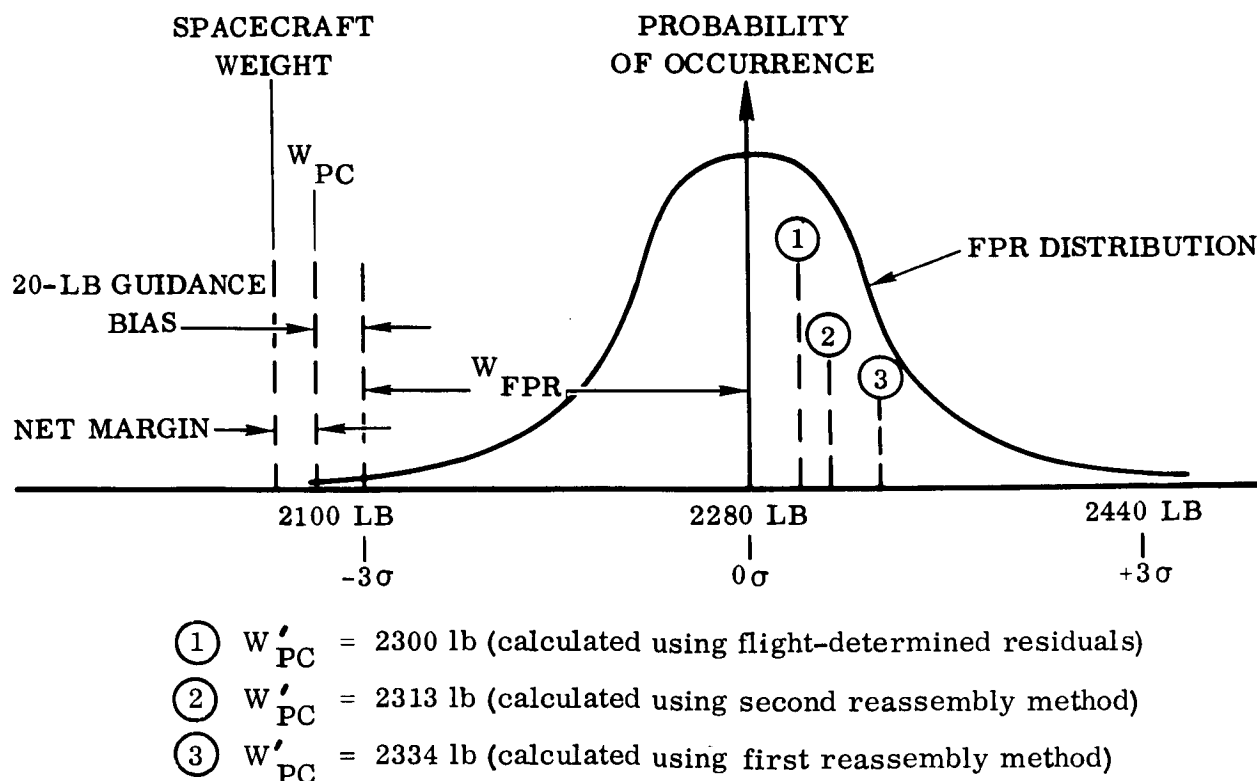


Figure 7-1. Statistical Treatment of Payload Capability

$$W'_{PC} = W'_{BO} - W'_{JETT} \quad (2)$$

or equivalently

$$W'_{PC} = W_{PAY} + W_{ER} \quad (3)$$

where

W'_{PC} is postflight payload capability weight.

W'_{BO} is total weight injected into the flight orbit ($W'_{BO} = W_{PAY} + W_{ER} + W'_{JETT}$).

W'_{JETT} is the separated Centaur stage weight at Centaur burnout excluding the excess propellant residual.

W_{ER} is the propellant residual in excess of trapped, gaseous, and propellant-utilization-system LH_2 bias.

W_{PAY} is the actual injected payload weight (2084 pounds for AC-6).

One method of computing the postflight payload capability using Equation 3 is based on flight determined propellant residuals. This is the most direct method for determining postflight payload capability and, hence, is probably the most accurate. W_{ER} based on the measured residuals (Section 7.5.2) is 216 pounds, so that W'_{PC} is 2300 pounds. This is 20 pounds greater than the predicted mean payload capability of 2280 pounds.

Payload capability based on the reassembly can be calculated by two separate methods. The first reassembly method uses Equation 2 with W'_{BO} determined from the reassembly. Payload capability for AC-6 using this method is 2334 pounds ($W'_{BO} = 6480$ pounds and $W'_{JETT} = 4146$ pounds). This is an increase of 34 pounds over W'_{PC} as computed using flight-determined residuals, which is within the ± 50 pounds quoted accuracy of the flight-determined residuals.

The second reassembly method of calculating payload capability was used in previous reassembly reports. This method consists of applying the Surveyor mission performance partials to vehicle configuration and system dispersions determined from the reassembly. Table 7-1 lists the vehicle system deviations between the preflight and reassembly trajectories for AC-6 along with the performance partials and payload deltas. The estimated Surveyor mission performance delta from Table 7-1 is +33 pounds. The value of payload using this reassembly method is 2313 pounds (2280 + 33).

Table 7-1. Estimated Surveyor Mission Performance Delta

PARAMETER (X)	AC-6 PREDICTED 3 σ DISPERSIONS (Reference 13)	FLIGHT DEVIATIONS (1)	PERFORMANCE PARTIAL ($\Delta W_{PAY}/\Delta W$)	DELTA PAYLOAD (ΔW_{PAY})
Booster Staging Acceleration	+0.077 g	+0.05 g	(4)	+1
Booster Thrust	± 3000 lb	+1106 lb	1/161 lb/lb	+7
Booster I _{sp}	± 2.4 sec	-2.47 sec	23.6 lb/sec	-58
Sustainer Thrust	± 855 lb	1449 lb	1/85 lb/lb	+17
Sustainer I _{sp}	± 2.8 sec	4.1 sec	15 lb/sec	+62
Sustainer Res- iduals (Soft Decay Error)		+322 lb		-36
Centaur Thrust ⁽²⁾	± 424 lb	-499 ⁽³⁾ lb	1/62.6 lb/lb	-8
Centaur I _{sp} ⁽²⁾	± 3.54 sec	-1.3 ⁽³⁾ sec	28 lb/sec	-36
Atlas Drag & Holddown				+82
Reduced AC-6 Holddown				<u>+2</u>
Payload Delta				+33

(1) $\Delta X = X_{\text{reassembly}} - X_{\text{preflight}}$

(2) Two engines

(3) Reassembly mean value for nulled PU valve angle minus preflight reference value

(4) Variable with stage time (Reference 2)

The Delta payload capabilities for AC-2, AC-3, AC-4, and AC-6 using the reassembly performance data are compared in Table 7-2. The postflight payload capabilities determined using the three methods presented are included, for comparison, in Figure 7-1.

Table 7-2. Atlas/Centaur Surveyor Mission Delta
Payload from Reassembly Performance

PERFORMANCE	AC-2	AC-3	AC-4	AC-6
Total Delta	+230	+211	+92	+33
Atlas Delta	+155	+198	+95	+77
Centaur Delta	+ 75	+ 13	- 3	-44

7.2 SEQUENCE OF EVENTS. The Atlas booster engine phase was terminated by guidance, based on attainment of a preselected thrust acceleration value measured by the guidance accelerometers. All subsequent discrete events until sustainer engine cutoff were initiated by the Atlas flight-control programmer as a function of elapsed time from booster engine cutoff (BECO). Atlas sustainer stage was terminated by a planned propellant depletion mode. All Centaur phases and discrete events, except main engine cutoff, were initiated and/or terminated by the Centaur flight-control programmer as functions of elapsed time from sustainer engine cutoff. Centaur main engine cutoff (MECO) is commanded by the guidance system when the required velocity-to-be-gained has been achieved.

The major trajectory flight-event times are compared in Table 7-3. Actual times were determined primarily from CM101A accelerometer data.

7.3 COMPARISON OF PREFLIGHT AND REASSEMBLY TRAJECTORIES. The preflight and reassembly trajectories are compared at the discrete points corresponding to start booster engine decay, start sustainer engine decay and Centaur main engine cutoff in Table 7-4. At start booster engine decay (determined by reassembly program iteration on booster stage time) the trajectory from reassembly was high, and fast, even though staging occurred approximately 1.5 seconds early.

A pattern of a high and fast Atlas booster phase trajectory and early booster engine cutoff has been established for Atlas/Centaur flights AC-2, -3, -4, and -6. A major cause of this discrepancy is an inaccurate preflight-simulation drag model. The discrepancy is reduced when the revised drag simulation, discussed in Section 7.6, is simulated in the preflight trajectory. Data for the AC-6 preflight simulation with the revised drag model are included in Table 7-4 for comparison. Also contributing to AC-6 early booster staging is higher-than-nominal booster and sustainer thrust and a significantly lower-than-nominal booster specific impulse.

Table 7-3. Flight Event Times

EVENT	ACTUAL TIME FROM LIFTOFF (sec)	ELAPSED TIME (sec)	
		PREFLIGHT	ACTUAL
Guidance to Flight Mode	-7.795	-8.0	T1-7.755
Liftoff (Vehicle 2-In. Motion): T1	0(1)	0.0	(1)
Start 20.461Deg Roll to Launch Azimuth = 94.539 Deg(2)	2.06	T1+2	T1+2.06
End Roll (2)	14.98	T1+15	T1+14.98
Start Pitch Program (2)	14.91	T1+15	T1+14.91
Booster Staging Discrete: T2	141.80	T1+143.31	T1+141.80
Start of Booster Engine Thrust Decay (3)	141.84	T2+0.00	T2+0.04
Booster Engine Package Jettison (2)	144.88	T2+3.1	T2+3.08
Admit Guidance Steering (2)	149.81	T2+7.95	T2+8.01
Jettison Centaur Insulation Panels Shock	171.65	T2+30	T2+29.85
Jettison Centaur Nose Fairing Shock	196.50	T2+55	T2+54.70
Sustainer Engine Cutoff (SECO): T3	234.28	T2+92.42	T2+92.48
Start Sustainer Engine Thrust Decay (4) (Soft Shutdown)	233.0	T3-2.87	T3-1.28
Atlas/Centaur Separation (Fire Atlas Retrorockets) (2)	236.29	T3+2.0	T3+2.01
Start Centaur Main Engines Command: T4(2)	242.77	T3+8.5	T3+8.49
Admit Guidance Steering (2)	246.80	T3+12.5	T3+12.52
Main Engine Cutoff Discrete: T5	679.08	T4+431.37	T4+436.31

(1) 1431:04.430Z

(2) Programmed event

(3) Reassembly value determined by iteration on stage time

(4) As simulated in reassembly (accurate determination of start of the decay is difficult due to the very gradual decrease in thrust during onset of decay)

Table 7-4. Preflight and Reassembly Trajectory Parameters

EVENT AND PARAMETER	REVISED DRAG-MODEL		
	PREFLIGHT	PREFLIGHT	RE- ASSEMBLY
<u>Liftoff</u>			
Total Atlas/Centaur Weight (lb)	303,510	303,510	303,510
Liquid Oxygen Weight ⁽¹⁾ (lb)	172,286	172,286	172,286
Fuel Weight ⁽¹⁾ (lb)	76,103	76,103	76,103
<u>Start Booster Engine Decay</u>			
Time (sec)	143.309	142.8310	141.836
Altitude (ft)	191,077	192,872	193,337
Range (n.mi.)	42.58	42.67	42.31
Inertial Velocity (ft/sec)	9,344.72	9,384.59	9,394.59
Inertial Flight Path Angle (deg)	21.479	21.719	21.887
Longitudinal Load Factor (g)	5.700	5.700	5.751
<u>Start Sustainer Engine Decay</u>			
Time (sec)	232.857	234.9	233.0
Altitude (ft)	465,531	477,094	477,792
Range (n.mi.)	172.43	177.17	175.89
Inertial Velocity (ft/sec)	12,569.67	12,695.10	12,757.50
Inertial Flight Path Angle (deg)	13.015	12.844	12.943
Longitudinal Load Factor (g)	1.801	1.800	1.829
Liquid Oxygen Weight Above Pump ⁽¹⁾ (lb)	704	706	677
Fuel Weight Above Pump ⁽¹⁾ (lb)	382	384	411
<u>Centaur Main Engine Cutoff</u>			
Time (sec)	675.596	676.46	679.08
Altitude (ft)	621,210	621,089	612,084
Range (n.mi)	1,519.21	1,528.21	1,544.35
Inertial Velocity (ft/sec)	36,003.700	36,002.835	36,000.960
Inertial Flight Path Angle (deg)	-3.037	-2.962	-2.875
Longitudinal Load Factor (g)	4.6750	4.6163	4.6319
Vis-Viva Energy (ft ² /sec ²)	-10,984,432	-11,051,584	-11,729,471
Weight (lb)	6,424	6,506	6,480

(1) Propellants are above sustainer pump inlet and contributing to net positive suction head (NPSH)

Start sustainer engine decay was approximately 0.14 second late compared to the pre-flight trajectory. However, sustainer engine cutoff (SECO) discrete was 1.45 seconds early. The early cutoff was due to a more rapid "soft-decay" phase on the flight compared to that predicted. Sustainer engine soft decay is discussed further in Section 7.4.1. At SECO the vehicle trajectory was still high and fast.

Centaur Main Engine Cutoff (MECO) occurred approximately 3.28 seconds late. Main engine burn time, however, was 4.94 seconds longer than predicted. Based on the reassembly results the longer Centaur main engine burn time was due to lower-than-predicted main engine thrust. The total cutoff time dispersion was reduced due to lower-than-predicted main engine I_{sp} and the effect of thrust and flow rate transients caused by propellant utilization valve angle variations, which were not simulated in the pre-flight trajectory. Even with a longer burn time, MECO occurred at a lower-than-predicted altitude (9,000 feet) and slower-than-predicted velocity (3 ft/sec). Both lower-than-predicted main engine thrust and I_{sp} contributed to these dispersions.

Figures 7-2 through 7-7 present plots of the primary trajectory parameters for flight from liftoff to MECO. Slight lofting during the Atlas and early Centaur phases (as in previous flights) is evident in Figure 7-2. The reassembly results showed that the lofting was caused primarily by higher-than-nominal Atlas booster and sustainer engine thrust and less-than-predicted drag. The vehicle inertial velocity as a function of time is presented in Figure 7-3. The velocity gain in the Atlas stage and loss in the Centaur stage is evident.

Flight data are included for Mach number and dynamic pressure in Figure 7-6. The correlation with the reassembly results is good and the time shift in the dynamic pressure curves noted for the AC-2 and AC-3 reassemblies is not evident. This improvement in the match (as in the AC-4 reassembly) is due to the revised drag simulation used in the reassembly (Section 7.6)

The flight-measured, angle-of-attack data, determined from differential pressure taps located on the Centaur nose fairing hemispherical cap, are shown in Figure 7-7 along with the preflight and reassembly data. Correlation of the reassembly with flight data is generally good. Some of the difference occurs because the reassembly is a steady-state simulation and does not include the effects of gusts.

7.4 PROPULSION

7.4.1 Atlas Stage Propulsion. In the reassembly of the Atlas stage, propellant utilization (PU) valve angle, liquid oxygen tank ullage pressure, fuel tank ullage pressure, and liquid oxygen temperature at the sustainer pump inlet were forced to follow the time histories measured during the flight. The PU valve angle, controlling the fuel-flow rate to the sustainer engine, is compared for the preflight and reassembly simulation in Figure 7-8. Liquid oxygen tank ullage pressure for the preflight and reassembly simulations is shown in Figure 7-9, and fuel tank ullage pressure for the preflight and

reassembly simulations is shown in Figure 7-10. Liquid oxygen temperature at the sustainer pump inlet measured on the flight and used in the reassembly is shown in Figure 7-11. The resulting liquid oxygen density computed in the simulation is compared to the preflight in Figure 7-12.

The effective specific impulse (I_{sp}), of the reassembly, during the constant PU-valve-angle phase prior to sustainer engine cutoff is 309.07 seconds. This is an increase of 2.4 percent from the preflight value of 301.87 seconds. A value of 314.79 seconds with a standard deviation of 1.3 seconds was obtained independently of the reassembly using BET position and acceleration data during the constant PU-valve-angle phase from 198 to 212 seconds. A similar value of I_{sp} with a standard deviation approximately double that above was obtained using telemetered guidance-computer, thrust-velocity data.

The generally good agreement and low standard deviation for I_{sp} obtained using the BET and guidance data would normally be accepted as sufficient proof of the correctness of the I_{sp} obtained. However, the method used (References 14 and 15) is based on the assumptions that thrust and flow rate are constant over the period of time being considered. Generally, it has been assumed that the small deviations in sustainer engine thrust and flow rate during the constant PU-valve-angle phase just prior to sustainer engine cutoff would not significantly affect the value of I_{sp} calculated using this method. Check calculations, based on a COMBO simulation of the sustainer phase during a constant PU-valve-angle phase similar to that on this flight, showed that a decrease in thrust of only 70 pounds would result in an overestimation of the I_{sp} , using this method, of approximately 4 seconds. If the flight thrust history were known the I_{sp} values could be corrected. However, unless an accurate measure of sustainer thrust history at altitude can be found, the I_{sp} values calculated from BET and guidance data are of little value. It is recommended that in future Atlas reassemblies no attempt should be made to calculate sustainer stage I_{sp} using the method of References 14 and 15.

The preflight and reassembly Atlas propulsion parameters are compared in Table 7-5 together with engine log values. The booster engines for this flight are uprated versions of those used for the AC-2, AC-3, and AC-4 flights. Sea level rated thrust and I_{sp} for these engines are 330,000 pounds and 252.5 seconds, respectively. Nearly all the propulsion parameters determined from the reassembly are outside the predicted 3-sigma tolerances. These parameters were all within the 3-sigma tolerances for the AC-4 reassembly. It is doubted that the propulsion deviations are actually as large as indicated by the reassembly. However, there definitely were larger trajectory errors for the AC-6 flight than for the AC-4 flight. Part of the reason for large propulsion deviations from the reassembly is due to an inadequate determination of launcher mechanism holddown force, booster engine thrust decay, and aerodynamic forces for this flight. Booster engine decay is discussed in the following paragraphs; the other two sources of error are discussed in subsequent sections.

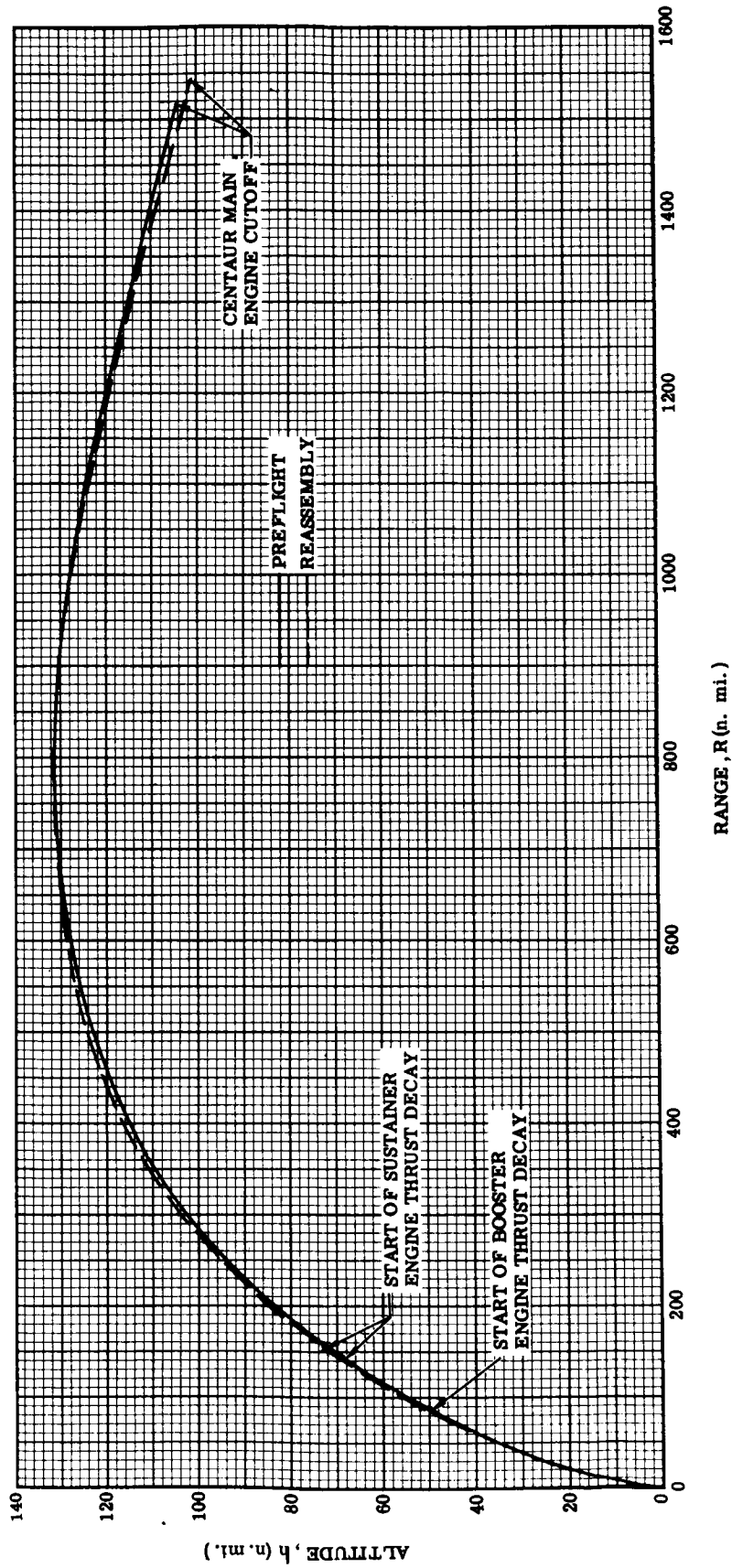


Figure 7-2. Vehicle Altitude versus Range

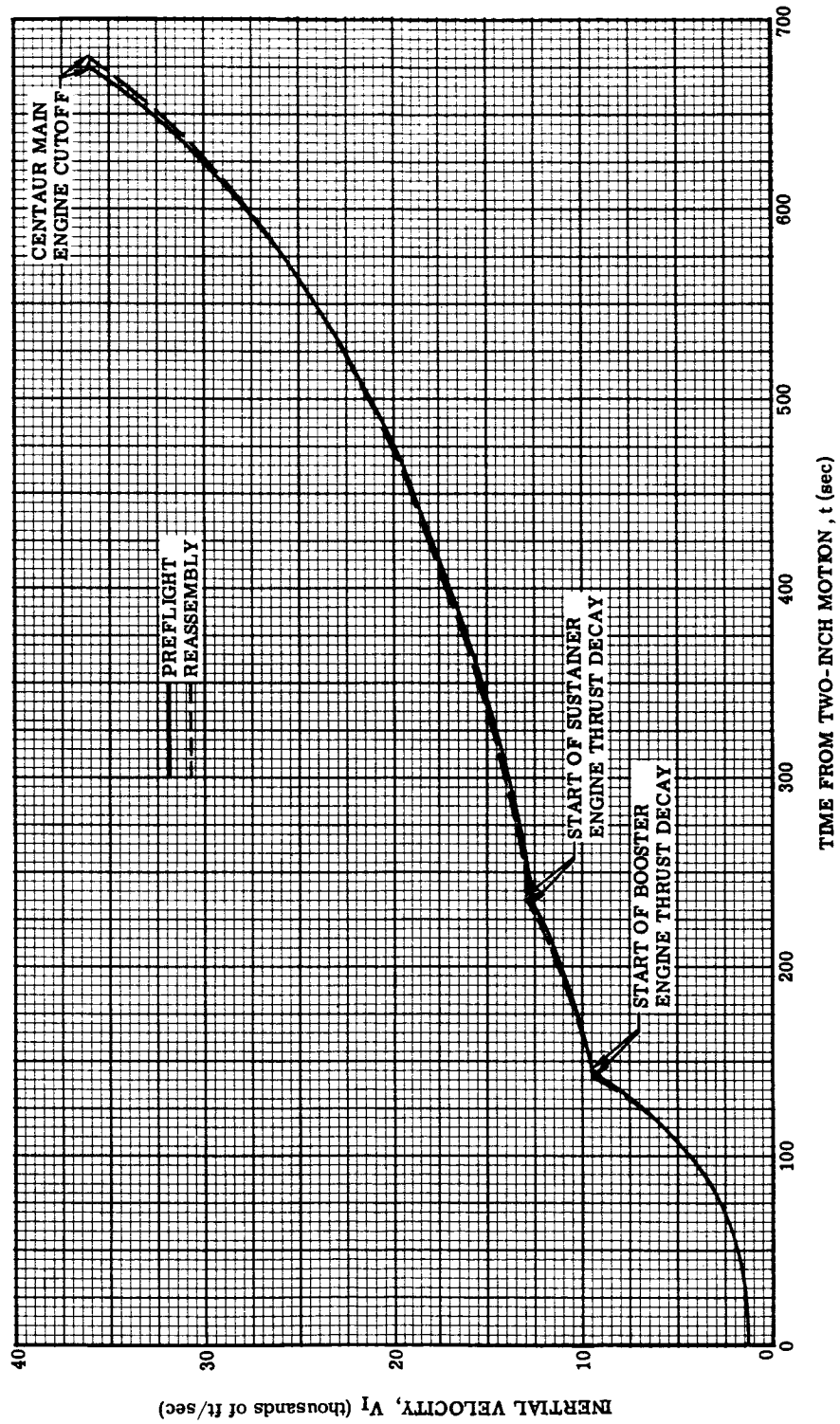


Figure 7-3. Inertial Velocity as a Function of Time

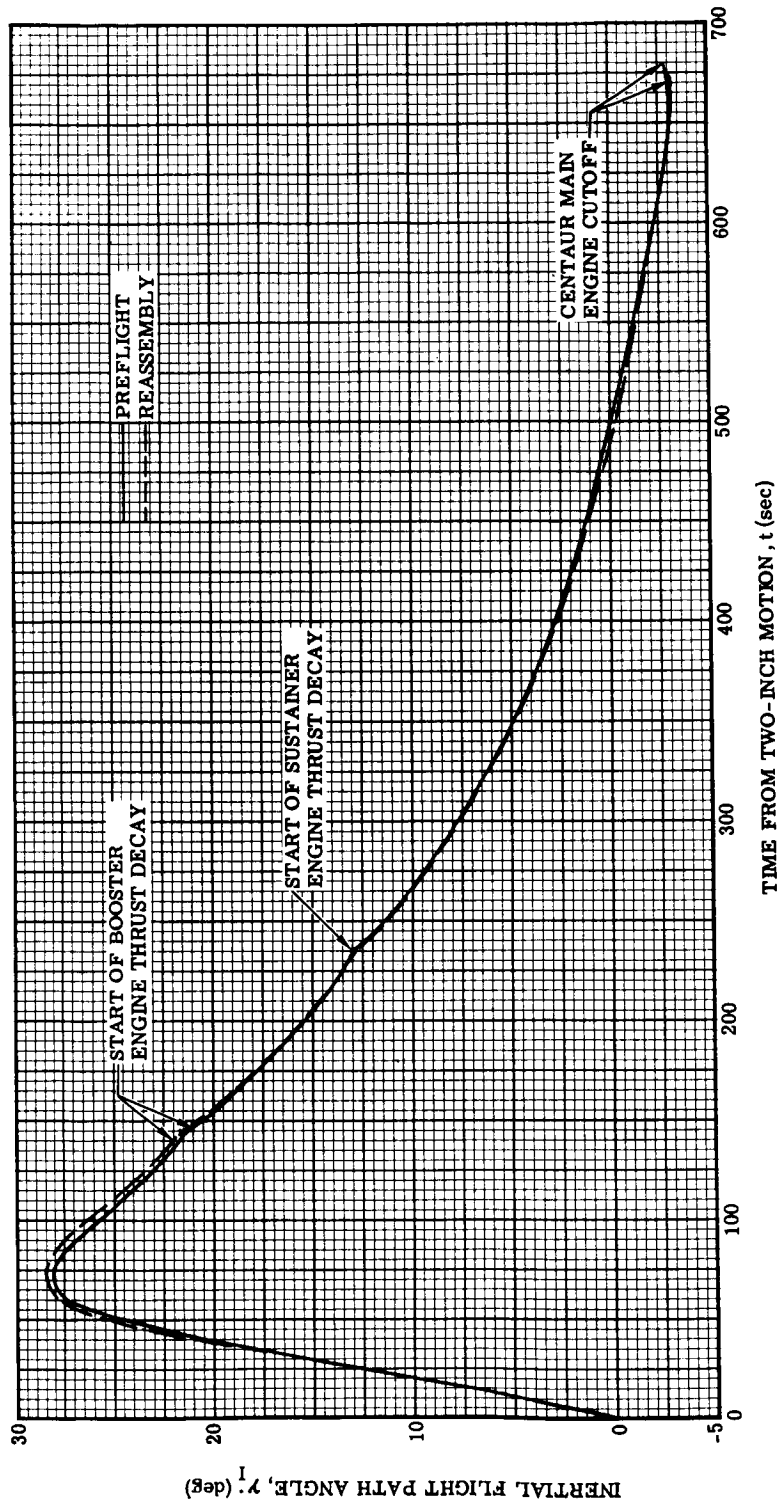


Figure 7-4. Inertial Flight Path Angle as a Function of Time

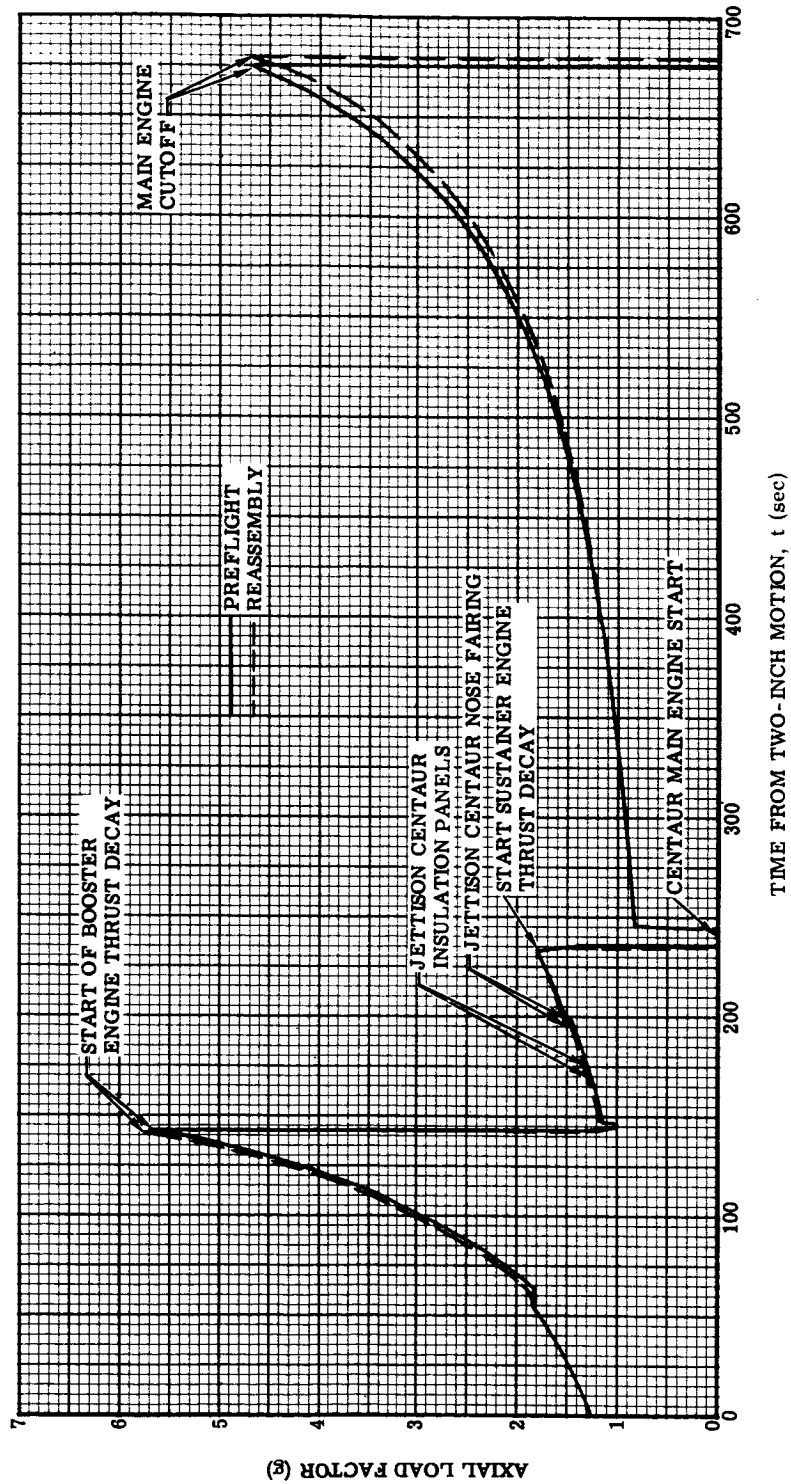


Figure 7-5. Axial Load Factor as a Function of Time

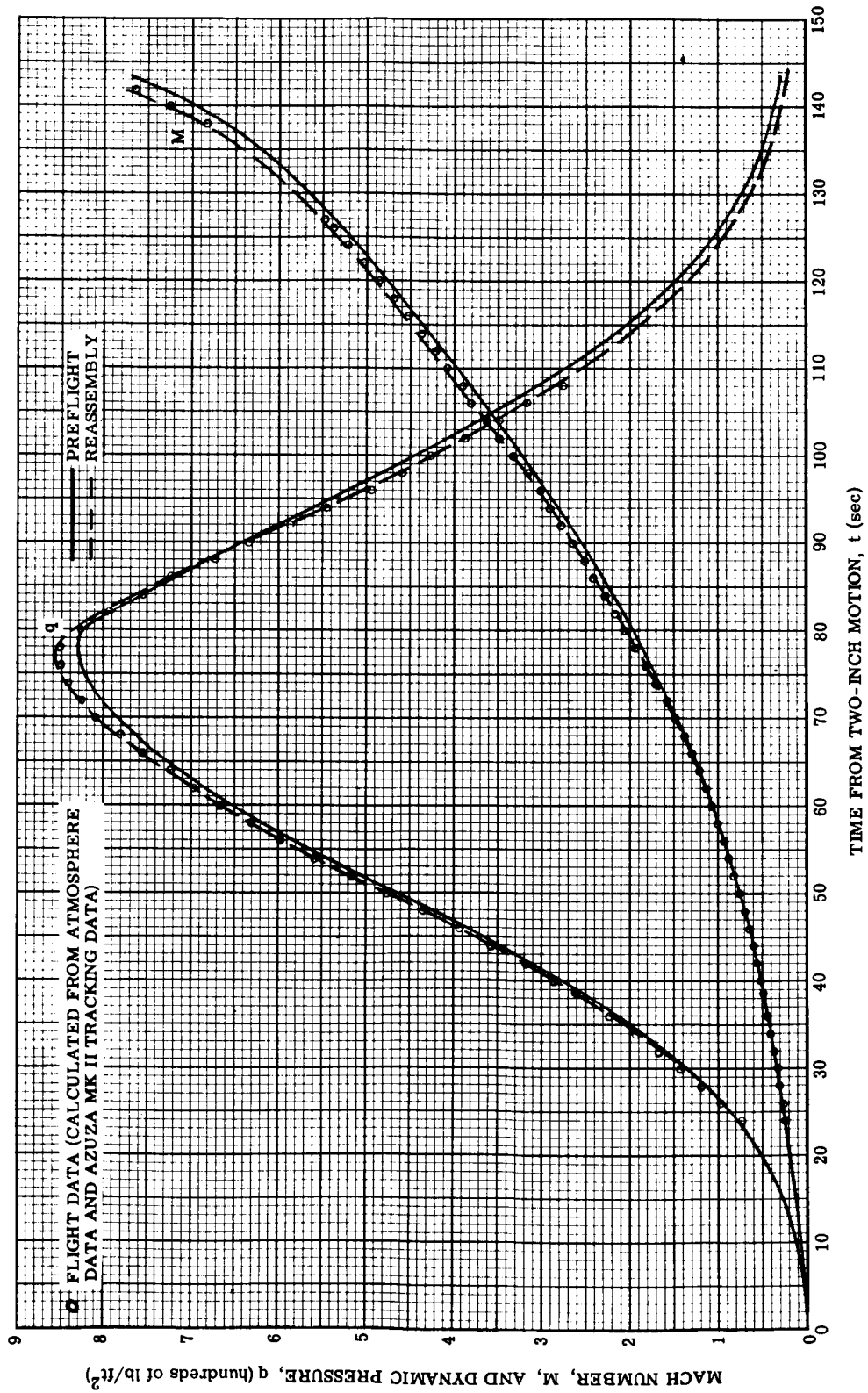


Figure 7-6. Mach Number and Dynamic Pressure as a Function of Time

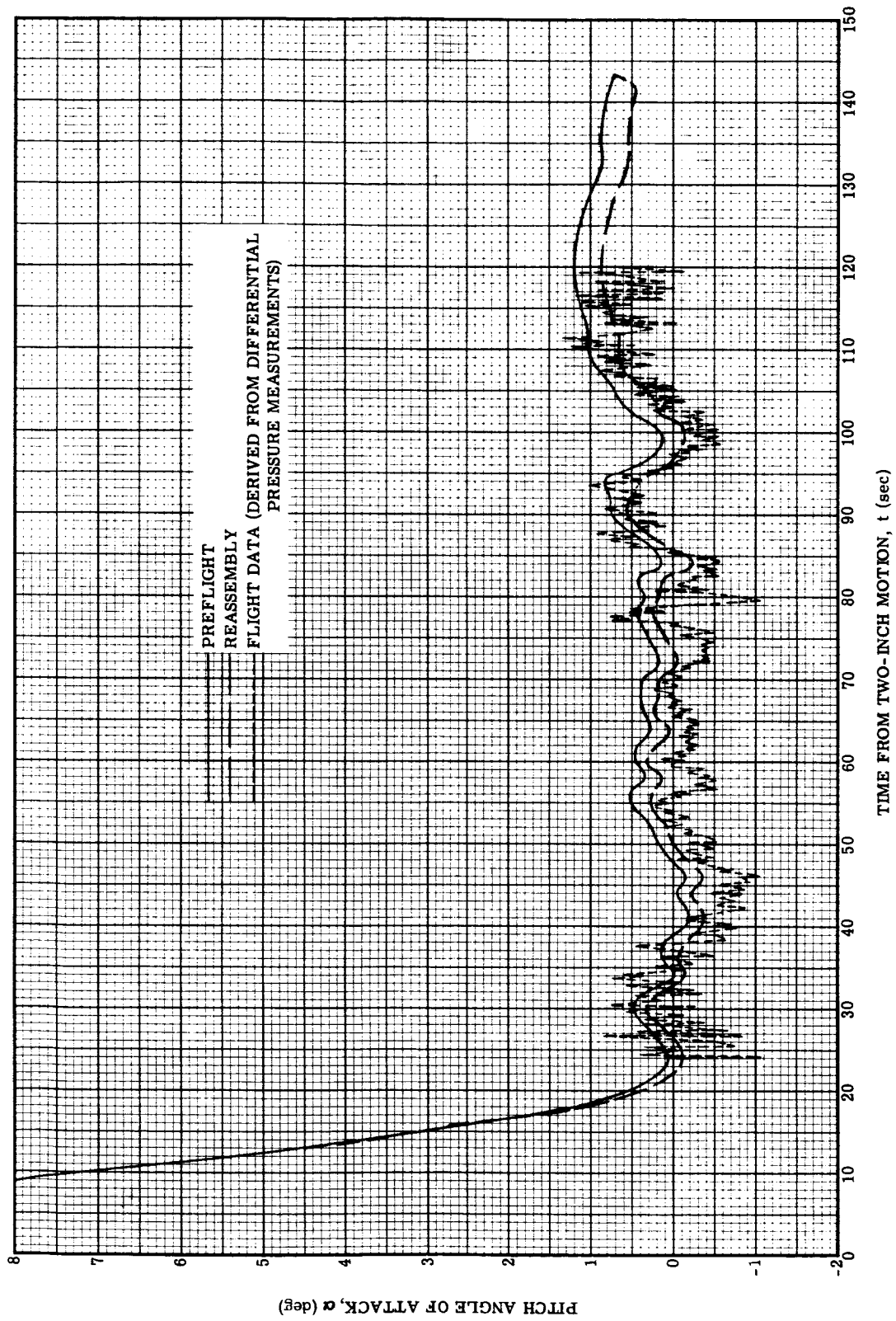


Figure 7-7. Pitch Angle of Attack as a Function of Time

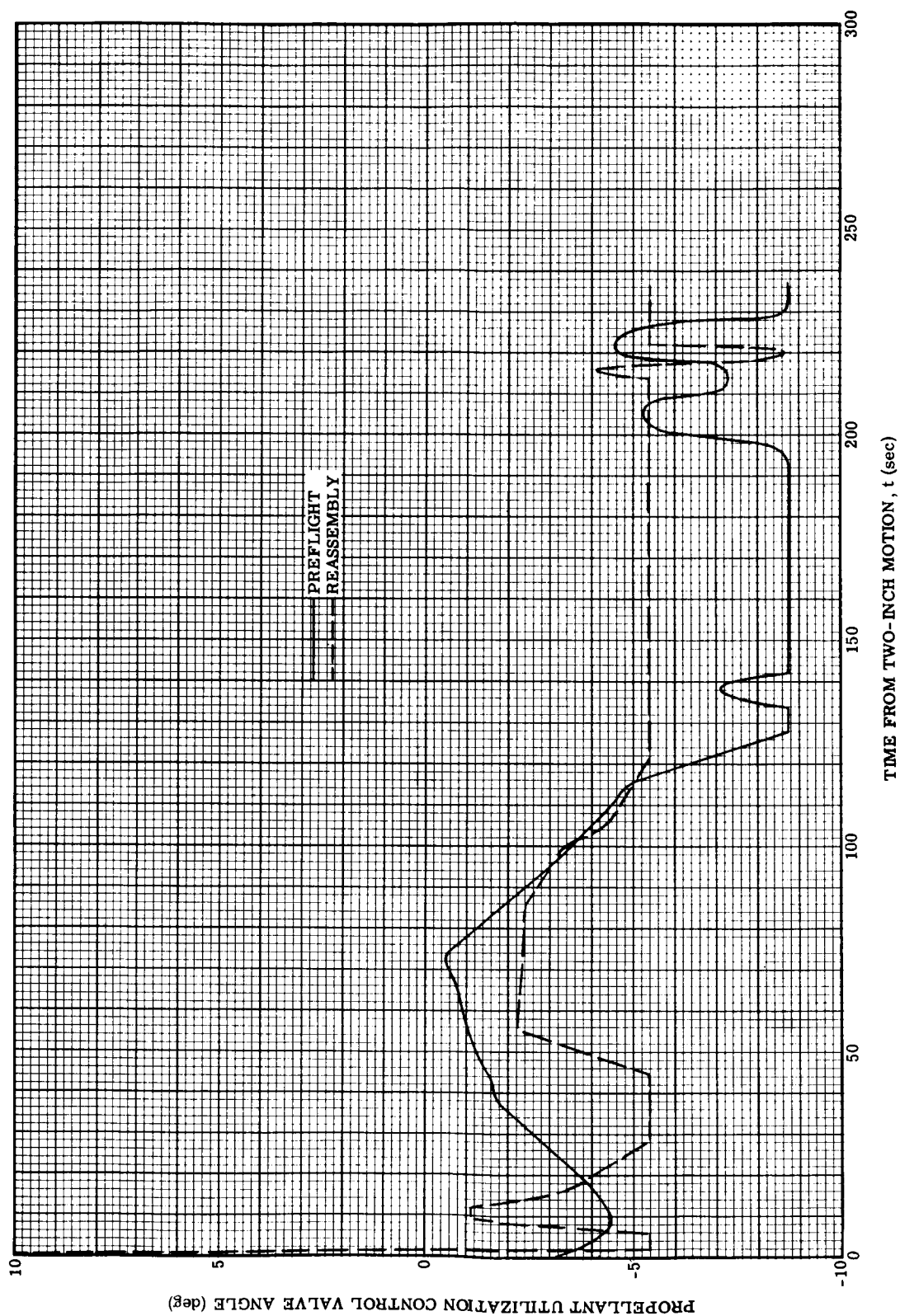


Figure 7-8. Atlas Propellant Utilization Valve Angle as a Function of Time

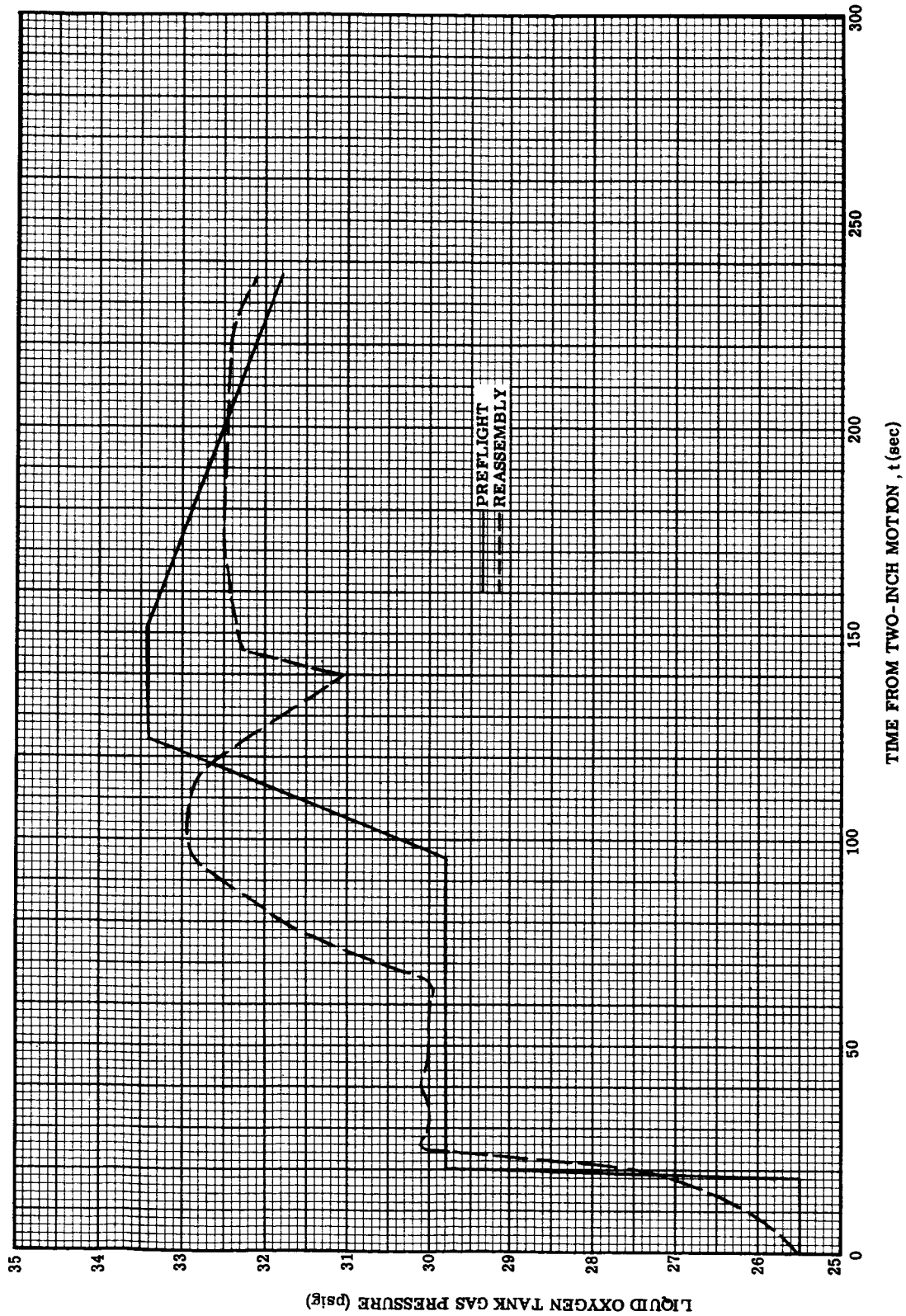


Figure 7-9. Atlas Liquid Oxygen Tank Gas Pressure as a Function of Time

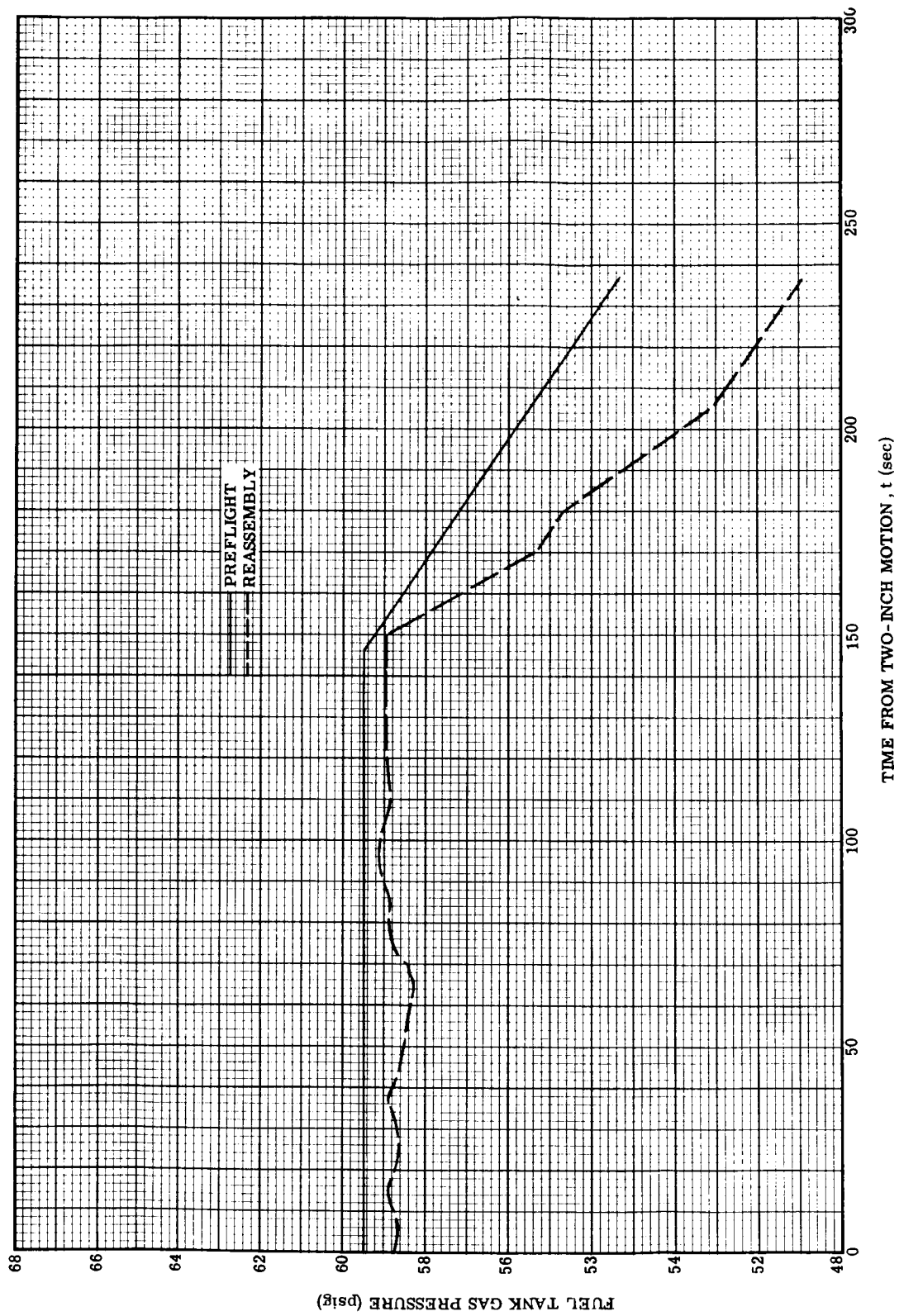


Figure 7-10. Atlas Fuel Tank Gas Pressure as a Function of Time

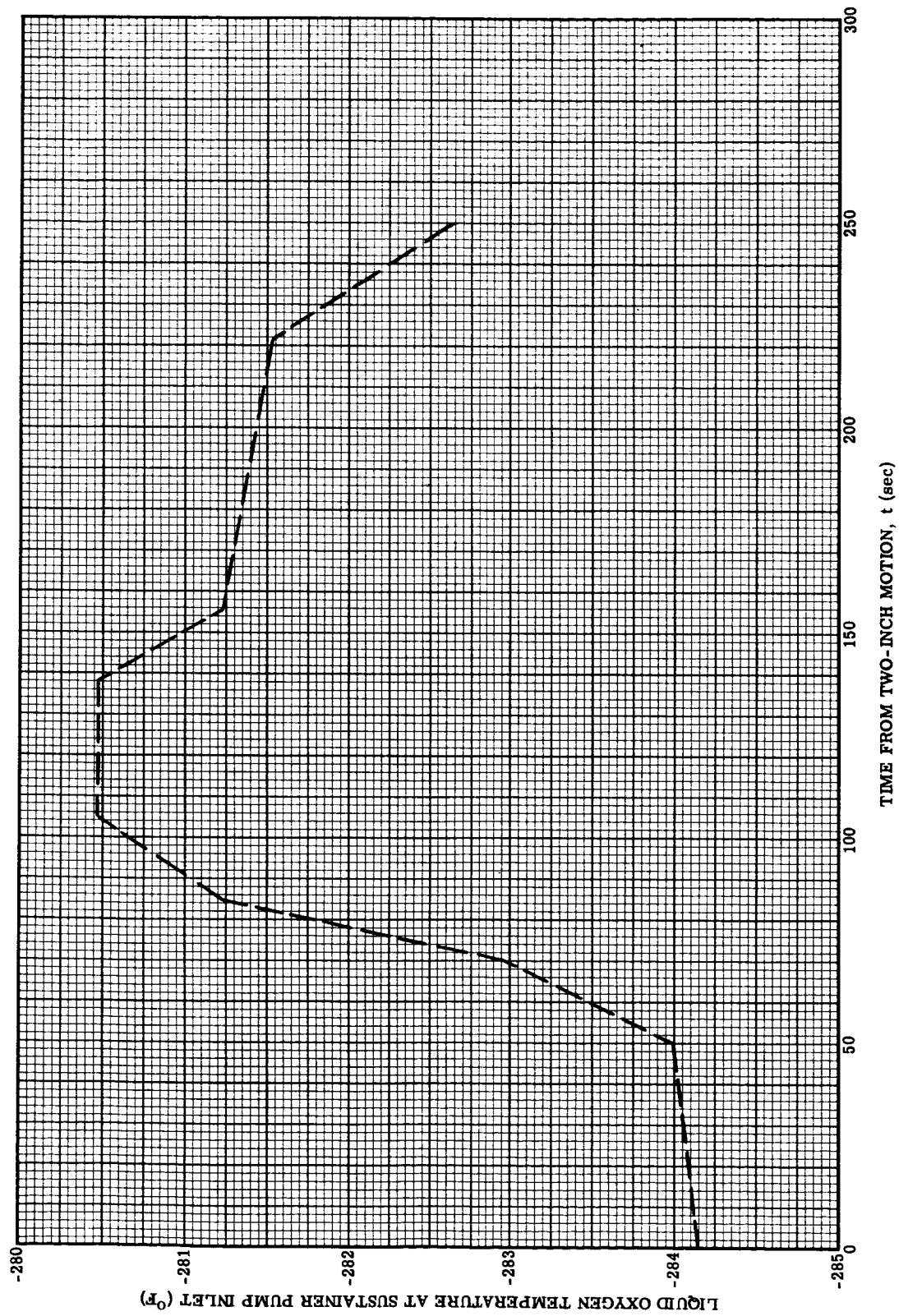


Figure 7-11. Atlas Liquid Oxygen Temperature as a Function of Time

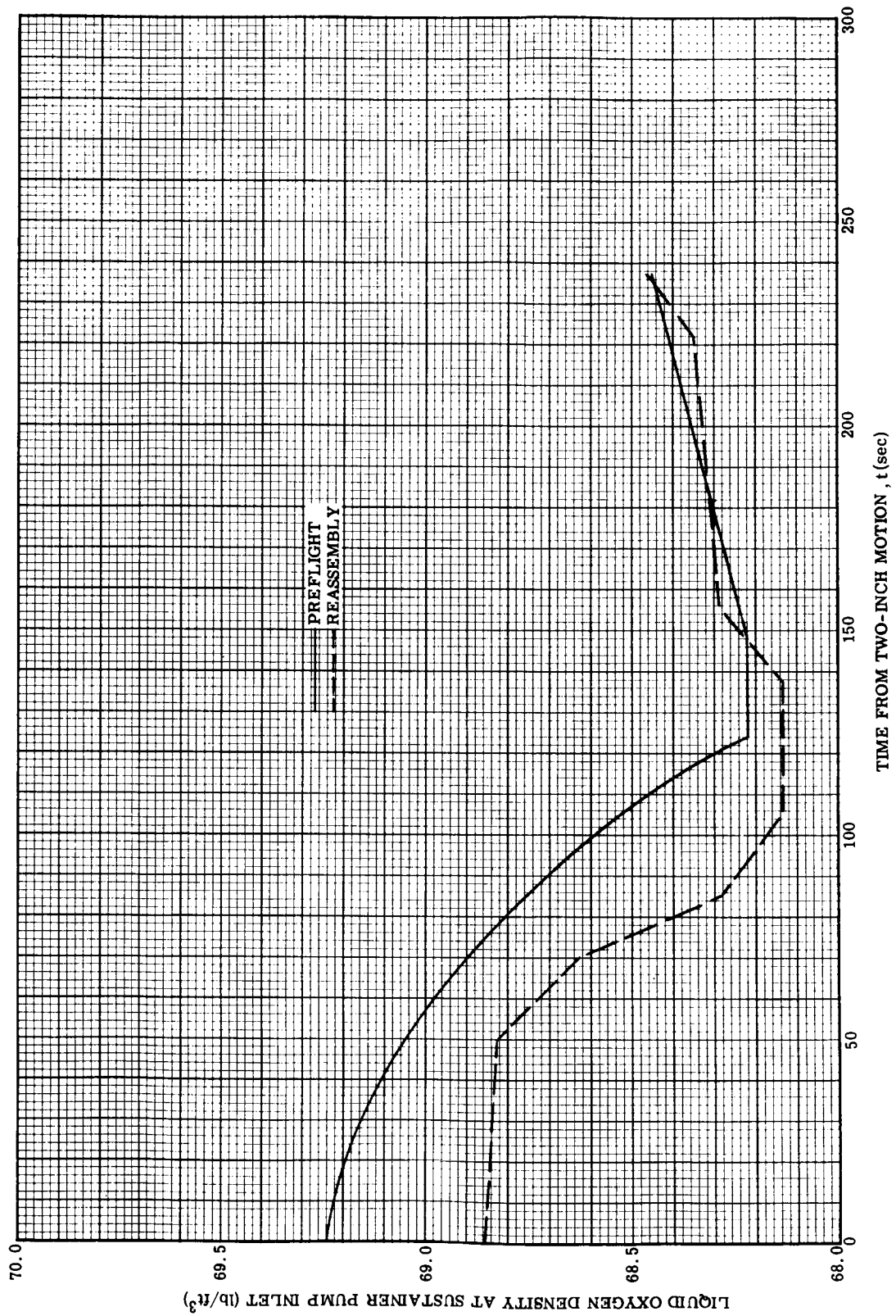


Figure 7-12. Atlas Liquid Oxygen Density as a Function of Time

Table 7-5. Atlas Propulsion Comparison, Reassembly and Preflight

PARAMETER	PREFLIGHT	ENGINE ACCEPTANCE	REASSEMBLY	ACTUAL (1) DISPERSIONS		PREDICTED 3- σ TOLERANCE (Reference 13)	
				ABSOLUTE	%	ABSOLUTE	%
(Altitude Reference Conditions)							
Booster Thrust (lb)	375, 804	374, 207	376, 910	+1, 106	+0.29	$\pm 3, 000$	± 0.80
Booster I_{sp} (sec)	289. 91	289. 52	287. 44	-2.47	-0.85	$\pm 2. 4$	± 0.83
Booster Mixture Ratio ($LO_2/RP-1$)	2. 278	2. 290	2. 264	-0. 014	-0. 61	$\pm 0. 023$	$\pm 1. 01$
(Sea Level Reference Conditions)							
Sustainer Thrust (lb)	57, 000	57, 000	58, 449	+1449	+2. 5	± 855	$\pm 1. 50$
Sustainer Plus Ver- nier I_{sp} (sec)	214. 41	213. 2	218. 52	+4. 1	+1. 91	+2. 8	$\pm 1. 30$
Sustainer Plus Ver- nier Mixture Ratio ($LO_2/RP-1$)	2. 27	2. 27	2. 27	0. 00	0. 00	Not Available	Not Available

(1) Reassembly minus preflight

Thrust-to-weight ratio as a function of time during Atlas booster engine decay is shown in Figure 7-13. The actual thrust-to-weight ratio was calculated using CM101A acceleration data with an output frequency of 20 points per second to determine the shape and guidance accelerometer data to determine the levels. The reassembly decay was determined using the preflight decay and iterating on booster engine start of decay time. As evident in Figure 7-13 this was not an entirely satisfactory procedure to use. The problem with this technique is due to the high correlation between booster start decay time, holddown force, and aerodynamic drag. Decay characteristics determined using the CM101A acceleration data in conjunction with guidance acceleration data are considered to yield quite accurate results; in future reassemblies, it is proposed that these data be used rather than iterating on stage time.

The Atlas sustainer thrust termination for this flight was by a planned propellant depletion mode. For this mode, a normal sustainer engine shutdown procedure consists of a soft shutdown phase and a hard shutdown phase. A description of the shutdown procedure is presented in Reference 2.

Thrust-to-weight ratio during the sustainer engine shutdown is shown in Figure 7-13 for the preflight and reassembly simulation. The reassembly thrust-to-weight ratio decay history was calculated using CM101A acceleration data with an output frequency of 20 points per second to determine the shape and guidance accelerometer data to determine the levels. The small BET-minus-reassembly position and velocity residuals during this phase of the reassembly (Section 6) demonstrates the accuracy of this data reduction technique. Sustainer engine flow rate during the shutdown was calculated assuming that the percentage of LO_2 and fuel flow-rate decay was equal to the percentage LO_2 and fuel pressure decay (measurements P330P and P351P, Reference 7).

The preflight start-of-sustainer-decay occurred at LO_2 residual weight of 704 pounds compared to a value of 677 pounds for the reassembly. However, the thrust decay after the start of soft shutdown is so gradual that an accurate determination of the start decay time from CM101A accelerometer data is impossible. Re-examination of the CM101A data indicates the start of decay could have been as much as 0.2 seconds earlier. If the start of decay were 0.1 seconds earlier than used in this analysis the reassembly and preflight LO_2 residual weights would be in agreement. However, the preflight and reassembly decays, once the decay has started, are quite different. The change in acceleration level, and hence magnitude of thrust change, is approximately equal during the two decays; but, the reassembly soft decay occurs in 1.3 seconds compared to 2.87 seconds for the preflight decay.

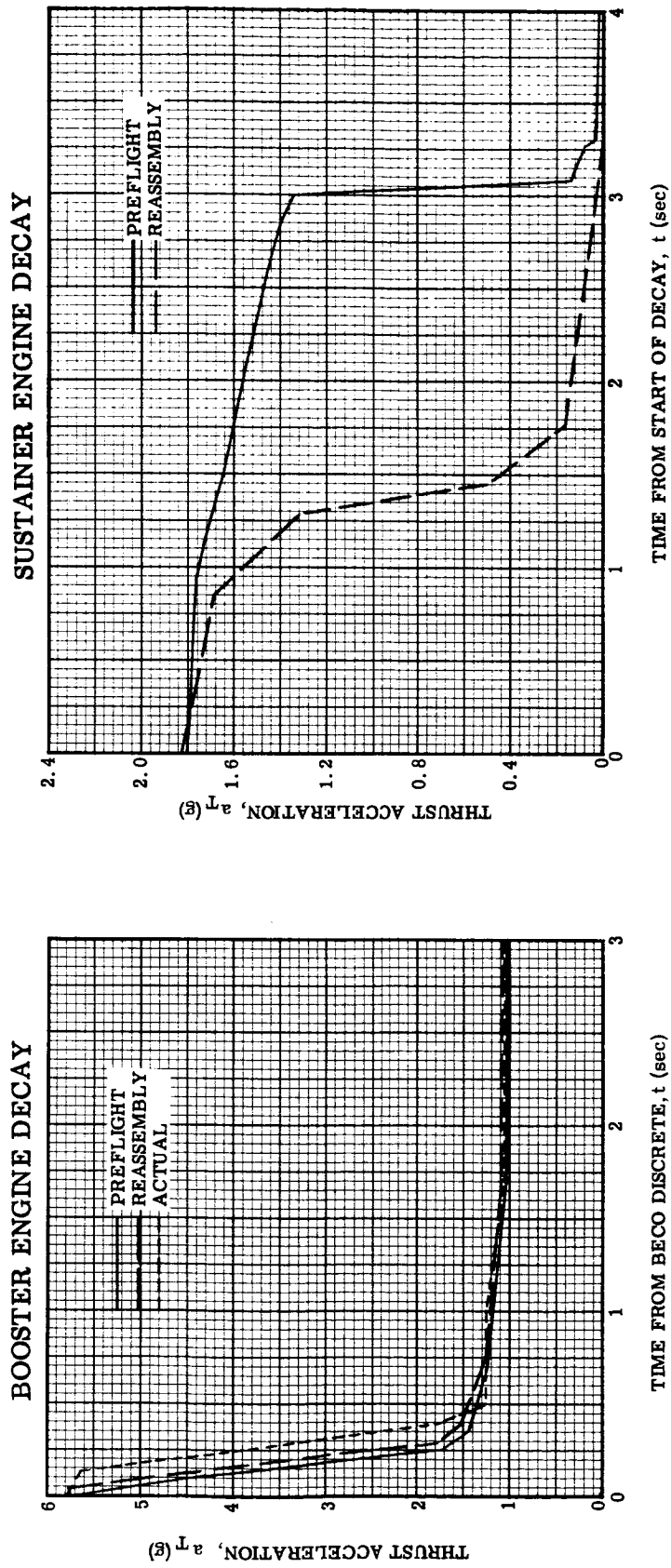


Figure 7-13. Atlas Booster and Sustainer Engine Decay Thrust Acceleration Histories

7.4.2 Centaur-Stage Propulsion. The AC-6 Centaur-stage propulsion differed significantly from previous Centaur-stage propulsion systems. The two main changes were the use of a closed-loop PU system and the use of the Pratt and Whitney RL10A-3-1 engines. The effects of the propellant utilization system on engine performance are illustrated by Figure 7-14. The sudden change in the performance curve at main-engine-start-plus-90-seconds is due to the activation of the PU servo-position valve (programmed from the vehicle autopilot to start functioning at this time) and commencing closed-loop PU operation. At this time (MES + 90 seconds) the engine mixture ratio reaches a maximum/minimum and remains essentially constant due to the PU valve being driven to its mechanical limit constraint by the combination of LH_2 and LO_2 weight dispersions. After the PU valve has reached the mechanical stop position, any increase in tank mixture ratio will not produce an increase in engine mixture ratio. As the PU system gains control, the PU valve will come off the mechanical stop and oscillate about the nominal. This variation is the result of constant correction of flow rates by the PU system. Just prior to MECO the valve again goes to the maximum/minimum mechanical stop because of the uncovering of the LO_2 probe.

The Centaur main engine thrust buildup must be simulated in the reassembly to obtain a good match with flight data. The reassembly thrust buildup (Figure 7-15) was calculated from engine chamber pressure data. The flow-rate buildup history for the reassembly, shown in Figure 7-15, is a modification of the preflight history. These thrust and flow-rate buildup histories are used with each of the total Centaur thrust and flow-rate histories that will be discussed in the following paragraphs.

The preflight trajectory does not simulate the PU system. Constant thrust and flow rate are used as in previous Atlas/Centaur trajectory simulations. Studies have shown that the effect on predicted payload capability of not simulating the PU system is small. However, the use of constant thrust and flow rate histories modified by multiplication factors in the AC-6 reassembly led to a poor match of position and velocity data.

Two other thrust and flow rate histories were investigated in the AC-6 reassembly. The Centaur Thermodynamic Group used the Pratt and Whitney regression equation with postflight input data to generate thrust and flow rate histories. These equations were developed by Pratt and Whitney from environmental control results using randomly-selected combinations of engine inlet conditions and propellant utilization valve angles. Using these equations, the percent nominal mixture ratio, thrust, flow rate, and specific impulse histories can be determined. The inclusion of these thrust and flow rate histories into the reassembly simulation, modified only by multiplication factors, also gave a poor match of position and velocity data. However, if the histories are broken at MES + 90 seconds and MES + 130 seconds, and levels modified independently in the reassembly, a good match is obtained. An even better match is obtained when the gradual decay in engine thrust during the first 90 seconds after MES (due to the engines seeking an equilibrium running temperature after a "cold" start) is simulated.

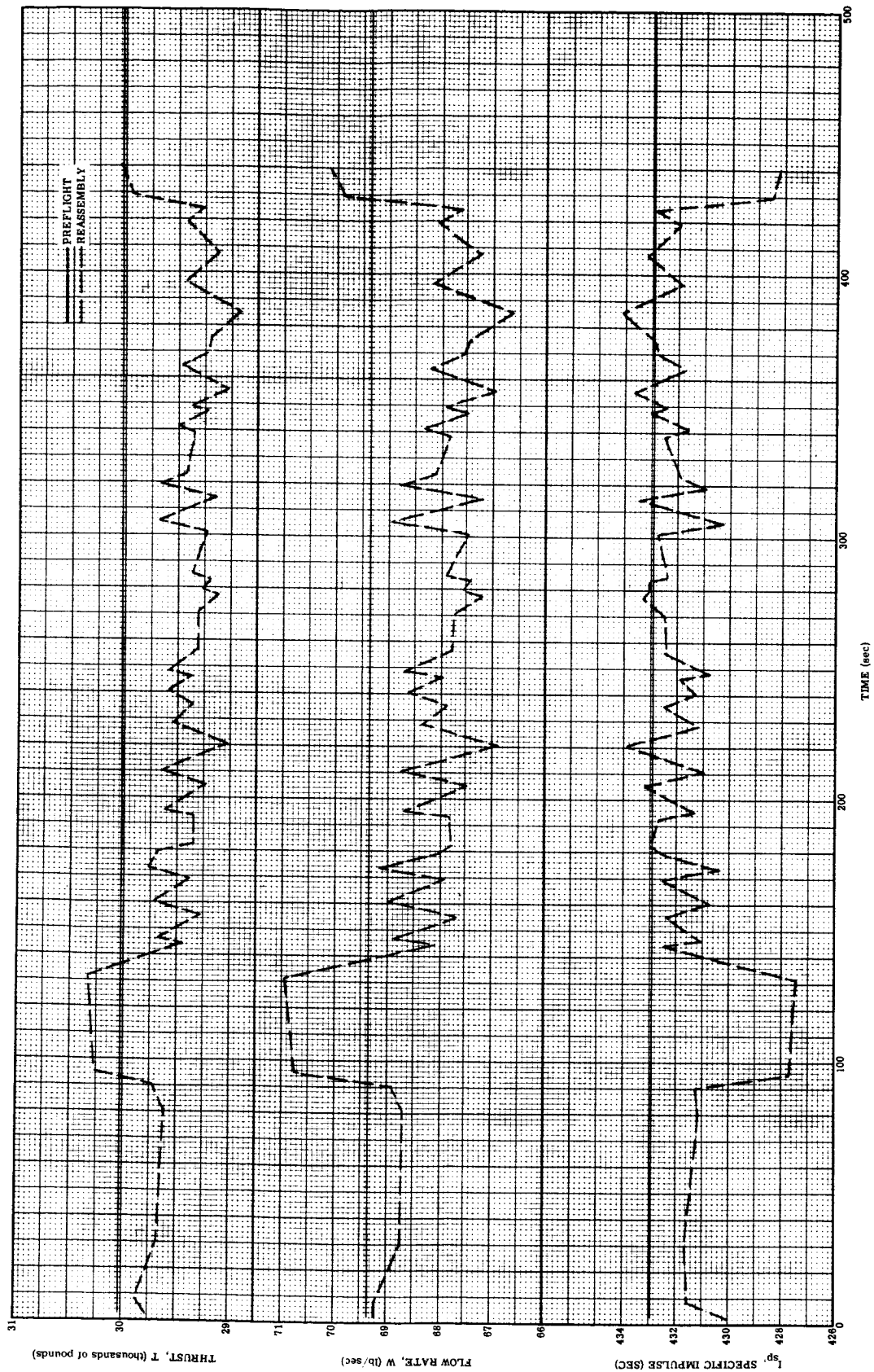


Figure 7-14. Centaur Main Engine Thrust, Flow Rate, and Specific Impulse

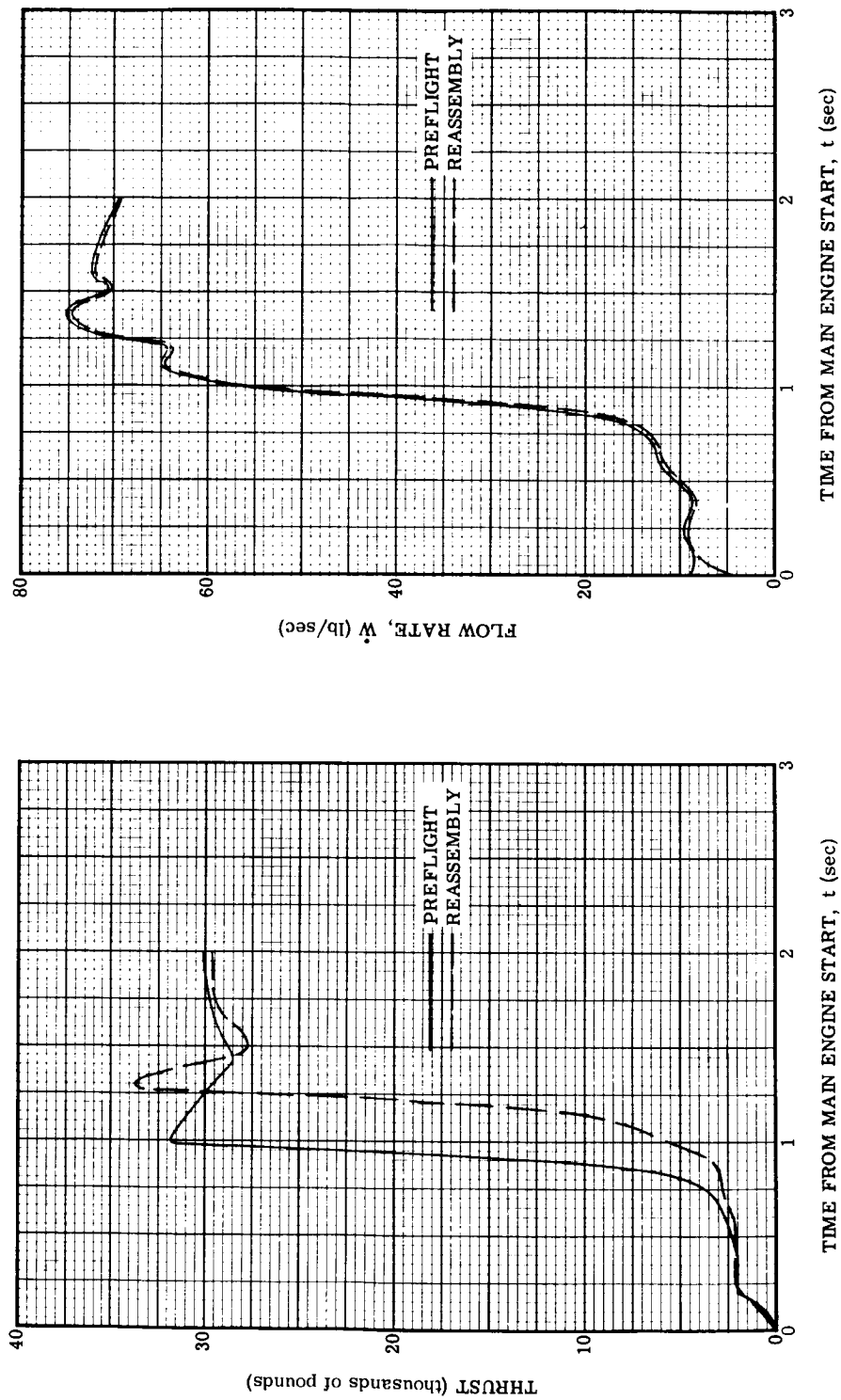


Figure 7-15. Centaur Main Engine Thrust and Flow Rate During Start Transient

This gradual decay is not evident in the histories determined from the Pratt and Whitney regression equations. A program developed by the Centaur Engine System Group (the second source for thrust and flow rate data) generates propulsion data by iterating on the engine mixture ratio. This program uses flight measured chamber pressure, venturi temperature, and venturi pressure as input. The result is engine thrust, specific impulse, mixture ratio, and propellant flows from MES + 4.0 seconds until MECO. Although the levels of these thrust and flow rate histories are evidently in error, these data when modified by multiplication factors in the reassembly give the best match of position and velocity of all the thrust and flow rate histories except the modified regression equation. Since the modified regression equation thrust and flow rate histories are essentially custom tailored by the reassembly, these data are not used in the AC-6 reassembly. The AC-6 reassembly is based on the Centaur Engine System Group thrust and flow rate histories (chamber pressure data).

Here is a comparison of the reassembly position and velocity residuals for the thrust and flow-rate histories investigated:

	MAXIMUM POSITION ERROR (Ft)	MAXIMUM VELOCITY ERROR (Ft/Sec)
Constant Thrust	1000	13
Regression Equation	700	10
Modified Regression Equation (3 Sections, 3 Multipliers, and Thrust Decay During First 90 Seconds)	160	3
Chamber Pressure	260	4

Centaur main engine thrust from the reassembly is 29,525 pounds. This compares to the value of 30,033 for the preflight simulation. The reassembly value of vehicle I_{sp}^* is 431.0 versus 432.3 seconds for the preflight simulation. Correcting the reassembly value for boost pump hydrogen-peroxide flow and boost pump thrust yields an I_{sp}^{**} of

* Specific impulse (I_{sp}) is the ratio of thrust to flow rate. Therefore, vehicle I_{sp} is the ratio of the sum of all the thrusts acting on the vehicle to the sum of all the flow rates for the vehicle.

** The engine I_{sp} is the ratio of main engine thrust to the propellant flow rate through the main engine.

431.6 seconds. (Reassembly values of thrust and specific impulse were determined by taking the mean of the thrust and I_{sp} when the PU valve was at a null condition.) For comparison, the mean values of thrust and engine I_{sp} determined from the Pratt and Whitney regression equations with the PU valve at a null condition are 29,950 pounds and 434.4 seconds respectively.

Centaur vehicle I_{sp} was also calculated from guidance computer thrust-velocity data. These data are first corrected for accelerometer scale factor, bias, and misalignment errors determined from preflight measurements, and then differentiated to obtain thrust acceleration. Vehicle I_{sp} is obtained directly by curvefitting the reciprocal of thrust acceleration as described in Reference 13 and 14. This technique is based on the assumption that the thrust is constant over the period of time being considered. The AC-6 thrust and flow rate histories are obviously not constant, but if the technique is used over the period when thrust is essentially oscillating about a mean value (386-667 seconds); the computed vehicle I_{sp} is 435.4 seconds. However, the thrust during this period is not only oscillatory, the mean value is varying more or less linearly with time. Vehicle I_{sp} computed from the reassembly using this technique (curvefitting the reciprocal of thrust acceleration) over the same time interval (386 to 667 seconds) is 435.6 seconds. However, the maximum Centaur vehicle I_{sp} from the reassembly (calculated as the ratio, at any time, of reassembly thrust to reassembly flow rate) is only 433.5 seconds. Based on the above and the analysis of this method of obtaining I_{sp} during the sustainer stage (Section 7.4.1), it is recommended that this method not be used except when thrust is truly constant.

As indicated, Centaur propulsion parameters determined by the various available post-flight techniques are not in agreement. These parameters are important in the determination of total vehicle performance. In particular, Centaur specific impulse is one of the most important parameters in determining Atlas/Centaur performance. Each second increase in Centaur I_{sp} causes a 28-pound increase in Surveyor-mission payload capability. Thus, the value of specific impulse must be known accurately to predict the true net vehicle performance capability. In addition, specific impulse dispersions about this value should be small and known accurately. If the specific impulse dispersion possible during flight is large, then a significant portion of vehicle weight that could be considered payload must be assigned to a propellant pad (Flight Performance Reserve). This pad is required to ensure, statistically, the delivery of the required payload into the specified orbit.

Because of all the discrepancies in the various engine models investigated, the AC-6 Centaur propulsion reassembly results are questionable. In order to achieve better results, a more accurate engine system simulation model must be defined.

A compendium of the values of Centaur I_{sp} based on preflight and postflight analysis for vehicle AC-2, -3, -4 and -6 is presented in Table 7-6. The RL10A-3 engine specifications apply to each of these flights except AC-6 which used the RL10A-3-1 engines.

Table 7-6. Compendium of AC-2, AC-3, AC-4 and AC-6 Vehicle I_{sp}

	AC-2 I_{sp} (sec)	AC-3 I_{sp} (sec)	AC-4 I_{sp} (sec)	AC-6 I_{sp} (sec)
Engine Specifications (RL10A-3 & RL10A-3-1 for AC-6) (1)	426.3	426.3	426.3	432.4
P&W Acceptance Data (1)	428.8	430.8	431.0	434.3
Reassembly	431.7	431.4	430.9	431.0
P&W Regression Equations (1)	428.3	431.1	430.4	434.0
Curve Fit of Guidance Acc. Data	431.1 $\pm$ 3	436.7 $\pm$ 9	431.0 $\pm$ 3	435.4

(1) Reduced to account for boost pump hydrogen-peroxide expenditure

7.5 WEIGHTS

7.5.1 Launch Day Weights. The following weights information was determined by the Convair Centaur Weights Group (Centaur propellant residuals were determined by the Centaur Control Systems Group).

a. Hardware

1. Table 7-7 is a list of San Diego actual weights and delta weights due to subsequent modifications prior to flight.

Table 7-7. San Diego Actual Weights and Delta Weights

COMPONENT	S. D. ACTUAL (lb)	DELTA (lb)
Interstage Adapter	1078	+9
Sustainer Dry	5667	Data not available
Booster Dry	6208	Data not available
Centaur Dry	3636	+7
Insulation Panels	1230	-12
Nose Fairing	1985	+21
Payload	2108	-24

2. Hardware weight uncertainties, as listed in Tables 7-8, 7-9, and 7-10, reflect only those random errors inherent in the weighing activities. Atlas booster and sustainer sections were weighed in a device consisting of four mechanical scales and two fixtures, one forward and one aft, that rest on two scales each. The Centaur vehicle was weighed in a horizontal position with overhead loadcells, two forward in tandem and two aft in tandem. The conical sections of the nose fairing, the insulation panels, and the interstage adapter were each weighed with overhead tandem loadcells. The barrel sections of the nose fairing were each weighed on two mechanical scales.

b. Propellant Loading

1. Fuel was tanked aboard the Atlas on 9 August 1965. Based on a density computed from temperature and API measurements, the fuel weight was computed to be 76,645 pounds. On the following day an additional 200 pounds were tanked in order to make the 100-percent probe indicate wet. Due to the long hold before aborting on the 10 August 1965 launch attempt, the fuel became cold soaked with a corresponding density increase and volume decrease. Consequently an additional 65 gallons were tanked to bring the fuel level to the 100-percent probe on launch day. The net effect of these toppings was an additional 635 pounds of fuel bringing the total RP-1 tanked to 77,280 pounds.
2. Atlas LO₂ topping was terminated with the liquid level at or above the topping high probe. It was necessary to top to this level rather than between the topping high and topping low probes due to the topping low probe being inoperative. At tanking complete, the LO₂ ullage pressure was recorded as 10.76 psig. The density associated with this pressure is 69.24 lb/ft³; the estimated LO₂ weight is 175,717 pounds. When the pressure was stepped to flight level, entrapped gas bubbles were forced into the ullage, and 450 pounds of liquid were dumped overboard through the vernier vent system.
3. Centaur LH₂ tanking was secured with the 99.8-percent probe indicating wet. The ullage pressure was 6.33 psig. The density was computed to be 4.198 lb/ft³ and the weight at Atlas liftoff was 5,271 pounds.
4. Centaur LO₂ tanking was secured with the 100.2-percent probe indicating wet. The ullage pressure was recorded as 15.63 psig and the density was computed to be 68.65 lb/ft³. The LO₂ weight at Atlas liftoff was 25,434 pounds.

c. Residuals

1. Residuals are those liquids and gases that are aboard the vehicle at the instant of engine cutoff and are not expendable.
2. Atlas residuals are those listed in Tables 7-8 and 7-9.
3. Centaur residuals are those listed in Table 7-10. The propellant residual in each tank was measured by the Advanced Propellant Utilization System. The LO₂ residual was also measured by a point level sensor (CU11X) at station 442.47 and agreed with the PU system data within 0.2 inches, or 38 pounds. The PU system data were corrected for thrust angle and inertia tube lag. The point sensor data were corrected for the thrust angle. The residual uncertainty was determined from the mast below the PU sensor and from the propellant consumption from PU probe uncover to main engine cutoff.

Table 7-8. Weight Summary, Booster Stage

BOOSTER STAGE WEIGHTS	WEIGHT (lb)	DISPERSION
Hardware	(6208)	(± 30)
Body Group	1895	
Propulsion Group	3323	
Hydraulic and Pneumatic Group	858	
Electrical Group	48	
Instrumentation Group	84	
Residuals	(1146)	(± 89)
Trapped RP-1	487	± 50
Trapped LO ₂	554	± 70
Helium	76	± 17
Unburned Lube Oil	29	± 17
Total Jettison Weight	(7754)	(± 93)

Table 7-9. Weight Summary, Sustainer Stage

SUSTAINER STAGE WEIGHTS	WEIGHT (lb)	DISPERSION
Hardware	(6,754)	(± 50)
Interstage Adapter	1,087	
Body Group	2,915	
Separation and Destruct Systems	43	
Propulsion Group	1,262	
Propellant Utilization	123	
Hydraulic and Pneumatic Group	396	
Electrical Group	311	
Guidance	205	
Instrumentation Group	412	
Residuals	(1,671)	(± 267)
Trapped RP-1	131	± 35
Trapped LO ₂	119	± 43
RP-1 Above Pump	297	± 50
LO ₂ Above Pump	415	± 100
Unburned Lube Oil	17	± 6
Gaseous Nitrogen	2	± 1
Gaseous Oxygen	603	± 235
Helium	87	± 17
Total Jettison Weight	(8,425)	(± 271)
Flight Expendables	247,904	(± 1,568)
Main Impulse RP-1 + Decay	75,829	± 877
Main Impulse LO ₂ + Decay	171,881	± 1,300
Lube Oil	173	± 15
Gaseous Oxidizer Vent	15	± 3
Helium - Airborne Chill	6	± 1
Ground Expendables (2.05 seconds)	(2,877)	(± 336)
RP-1 Expended	536	± 87
LO ₂ Expended	1,658	± 210
Lube Oil Expended	3	± 1
Exterior Frost Dumped	50	± 40
LN ₂ Dumped	140	± 140
LO ₂ Overboard Vent	40	± 10
Pre-Ignition GO ₂ Loss	450	± 200
Total Atlas Weight at Liftoff	(263,683)	(± 1,594)

Table 7-10. Weight Summary, Centaur Stage

CENTAUR STAGE WEIGHTS	WEIGHT (lb)	DISPERSIONS
Hardware - Basic	(5,727)	(± 10)
Body Group	940	
Propulsion Group	1,192	
Guidance Group	310	
Control Group	117	
Pressurization Group	138	
Electrical Group	266	
Separation Equipment	80	
Flight Instrumentation	447	
Miscellaneous Equipment	153	
Payload	2,084	
Hardware - Jettisonable	(3,230)	(± 14)
Nose Fairing	2,005	± 10
Tank Insulation	1,225	± 10
Residuals (at MECO)	(719)	(± 64)
Trapped LH ₂	66	± 5
Trapped LO ₂	68	± 5
Unburned LH ₂ { Includes LH ₂ Bias	81	± 11
Unburned LO ₂ { and FPR	195	± 49
Gaseous Hydrogen	86	± 17
Gaseous Oxygen	158	± 32
Hydrogen Peroxide	49	± 4
Helium	4	± 1
Ice	12	± 12
Expendables (Excluding Ground Vent)	(30,151)	(± 249)
Main Impulse LH ₂	4,969	± 49
Main Impulse LO ₂	24,874	± 244
Ground Vent - Hydrogen	6	± 1
Ground Vent - Oxygen	35	± 1
Inflight Chill - LH ₂	11	± 2
Inflight Chill - LO ₂	13	± 2
Boost Phase Vent - Hydrogen (Incl. Sust.)	58	± 5
Boost Phase Vent - Oxygen (Incl. Sust.)	126	± 7
Hydrogen Peroxide	49	± 4
Helium	1	± 1
Ablated Ice	50	± 10
Total Centaur Weight at Liftoff	(39,827)	(± 271)

7.5.2 Centaur Propellant Expendables and Residuals. The reassembly weights are the same as the weights for the preflight trajectory (Section 2) except for Centaur main impulse expendables and residuals. An evaluation of these quantities from flight data was possible on AC-6 because the residual probes uncovered. Matching the residual weight at MECO was attempted in the reassembly with adverse effects (position and velocity match errors were doubled). However, by allowing the reassembly to determine the proper value, MECO weight was match within 34 pounds; this is within the ± 50 pound tolerance of the flight-determined residual weights. Postflight information obtained from Centaur Weights and Centaur Control System Groups yield:

	<u>WEIGHT of LO₂ (lb)</u>	<u>WEIGHT of LH₂ (lb)</u>
Tanked propellants at liftoff	25,434	5,271
Expended and gaseous propellants	25,171	5,124
Propellant residual (at MECO, including trapped LH ₂ = 66 lb and LO ₂ = 68 lb)	263 $\pm$ 49	147 $\pm$ 11
Remaining usable	195	81
Total usable		276

The total weight of usable propellants at main engine cutoff is usually zero for the preflight trajectory, however, a flight performance reserve of 180* pounds and a propellant utilization system LH₂ bias of 60 pounds could be used to provide main engine impulse. However, only the amount of residuals in a ratio equal to the engine null mixture ratio could be burned. For AC-6 payload capability analysis (Section 7.1), it was assumed that the residuals in excess of trapped, gaseous, and propellant-utilization-system LH₂ bias (LH₂ bias equal to 60 pounds for compatibility with preflight analysis) could be simply replaced by payload. Excess residuals were, thus, equal to 216 pounds (276 lb - 60 lb).

* Including a 20-pound margin to account for the probable error in FPR due to using an idealized guidance simulation for FPR determination.

7.6 AERODYNAMIC CHARACTERISTICS. An early analysis of Atlas booster phase (Reference 16) showed a consistent pattern of differences between preflight and post-flight acceleration data for AC-2, -3, and -4 that suggested a revision of an axial-drag coefficient and an addition of a separate base thrust term. Since the forebody drag component is well known from wind tunnel testing, errors in the drag model were attributed to inadequate simulation of engine-on base-pressure effect. Formerly, the base thrust at altitude was considered a negative drag effect (note preflight drag coefficient Figure 7-16), and was therefore computed as a function of dynamic pressure and Mach number.

Reference 16 was later reviewed and slight changes were made on the basis of both the review and the incorporation of more detailed AC-4 reassembly results. The revised drag simulation thus determined has been incorporated in current Atlas/Centaur preflight simulations. This revised drag simulation (Reference 17) and the analysis leading to its adoption are discussed in this section.

The delta force curves shown in Figure 7-17 were generated in the following manner. Preflight weight was multiplied by preflight acceleration and plotted versus preflight pressure ratio (P/P_0). Postflight reassembly weight was multiplied by postflight guidance acceleration and plotted versus pressure ratio from the reassembly. These two curves were then differenced at the same pressure ratio and the results are the curves of Figure 7-17. These curves show that there is a consistent error for the four Atlas/Centaur flights. The same values when plotted versus time did not show a consistent error, indicating that the error is pressure dependent rather than time dependent.

The booster package is jettisoned before the pressure ratio reaches zero, so the last part of delta force curve can not be determined accurately. Since the last few data points available appeared to be linear, a straight line was arbitrarily extrapolated through them (this is indicated by the dashed portion of the curves). A considerably smaller value for delta axial force at $P/P_0 = 0$ could be obtained if the change in the slope with respect to P/P_0 is considered. From theoretical considerations, it is highly probable that the base force at zero ambient pressure is very small.

Although no particular function of ambient-pressure-dependent base force could be rigidly justified on the basis of the available data, a linear approximation of $BF = 4500 (1 - P/P_0)$ lb was mutually agreed upon by LeRC and Convair representatives for interim use in an empirically revised drag model. Once the pressure-dependent base

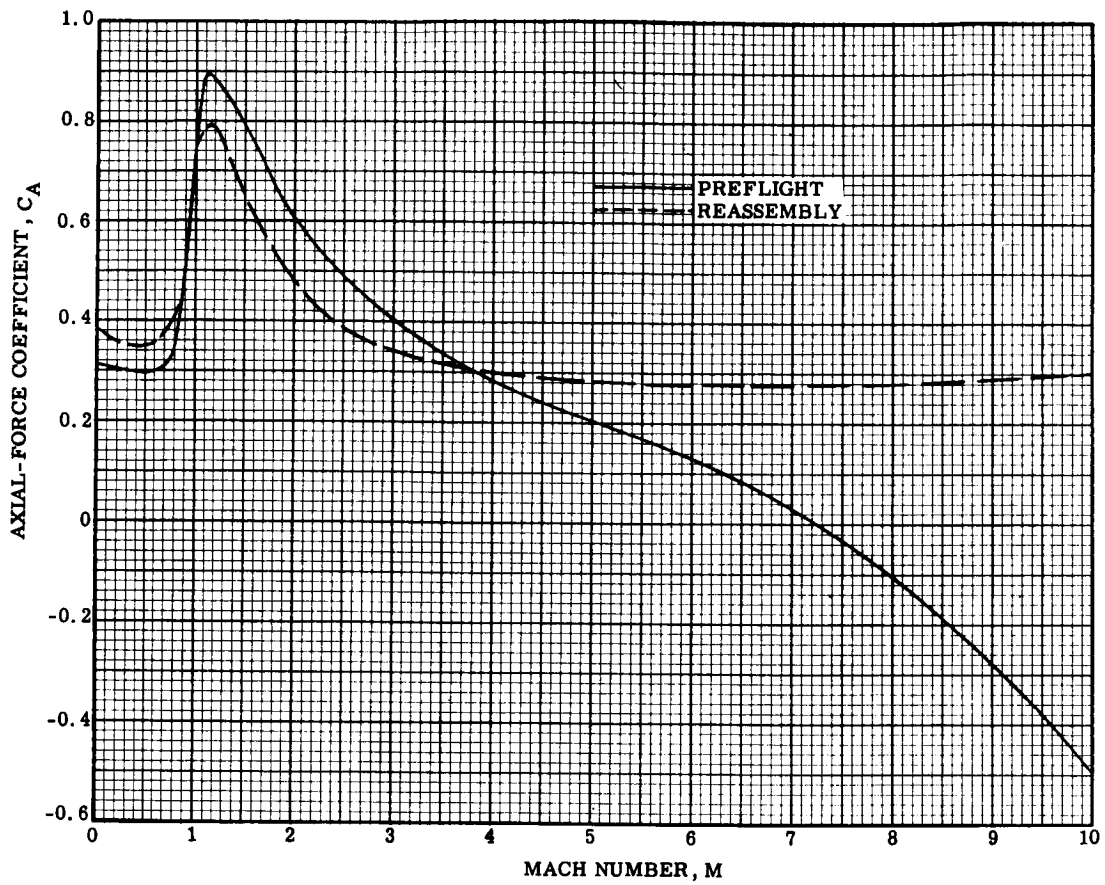


Figure 7-16. Mach Number Variation of Aerodynamic Axial-Force Coefficient, $\alpha_T = 0$

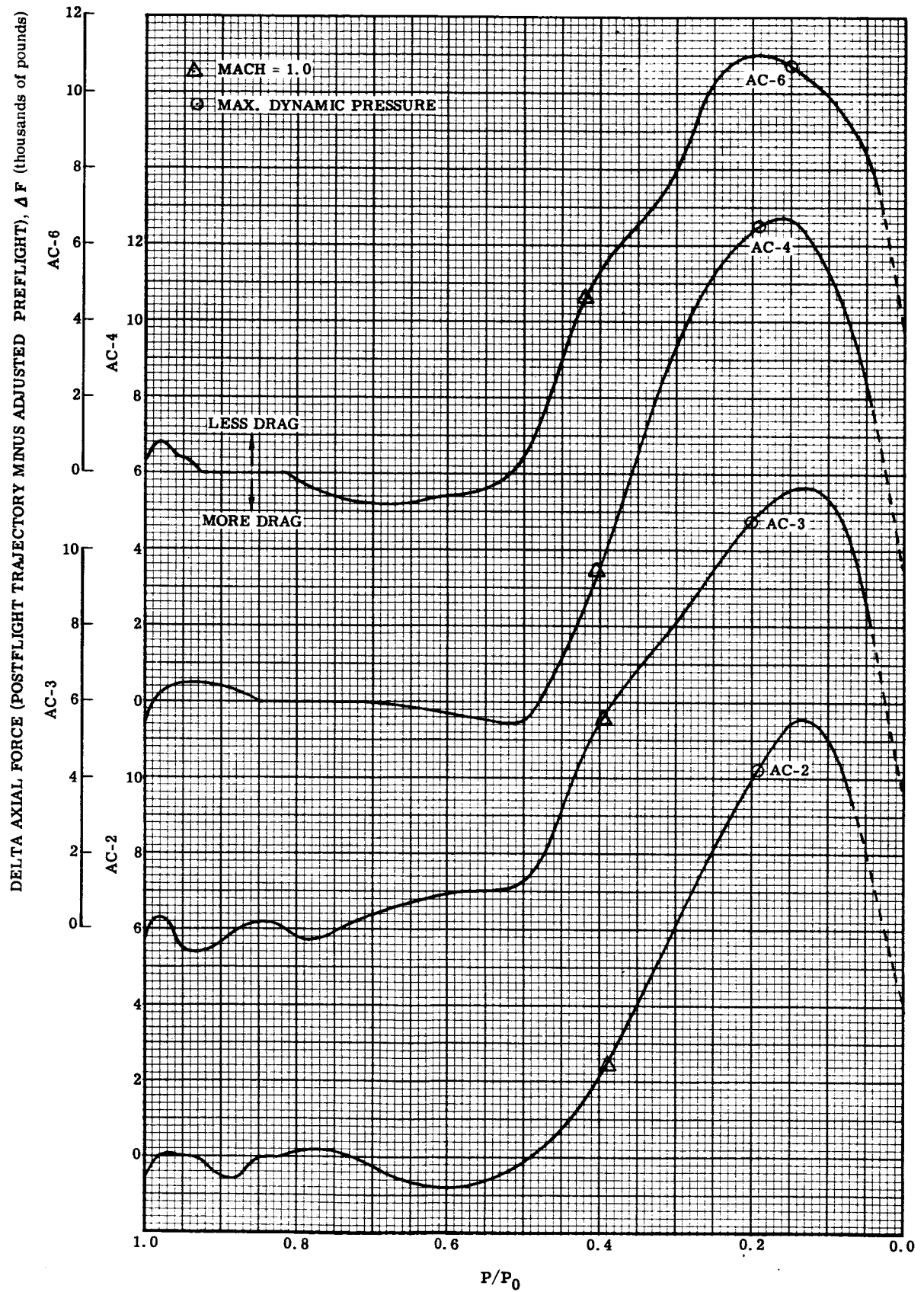


Figure 7-17. Delta Axial Force versus Pressure Ratio

force and holddown force terms were defined, the analysis turned to revision of the q -dependent drag coefficient. The old drag coefficient was modified to essentially eliminate the delta force not accounted for by the base pressure or holddown terms. (The AC-4 postflight reassembly was used.) Errors in the AC-4 acceleration history were thus reduced to within the noise level of the measured acceleration data. Although derived primarily from AC-4 data, proof of the general applicability of the revised drag model has been demonstrated empirically by the marked improvement of acceleration matches in the AC-2, AC-3, and AC-6 trajectory reassemblies (Figure 7-18).

The revised drag model gives a payload gain of 82 pounds. By direction of LeRC, 30 of the 82 pounds were added to the FPR as a contingency for base drag uncertainty pending further flight test data.

The AC-7, -8, and -9 flights will have extensive base pressure instrumentation. This information should contribute to a better understanding of the factors that affect the engine-on base pressure. It may then be possible to further revise the drag model to coincide more nearly with the actual physical situation.

7.7 HOLDDOWN FORCE. As discussed in Reference 16, there is a holddown force exerted on the missile by the launcher release mechanism during the vertical rise after 2-inch motion. This force contributes to the acceleration difference between predicted and flight-test data and thus, should be simulated if the reassembly solution is to be meaningful. Recent studies indicate there is an additional holddown force, which has been attributed to a base suction force at liftoff. This force is included in the holddown simulation. Holddown force was determined in the AC-6 reassembly by using a holddown force multiplication factor (K) as a control variable. The reference holddown force was that determined for AC-4 (Figure 7-19) with $K = 1$. The reassembly value of holddown multiplication factor determined for AC-6 is 0.386.

As a result of later attempting this type of reassembly with a preflight drag model, it was found that the reassembly holddown multiplication factor is a strong function of the drag model used. Unless the drag model is extremely accurate, it is undesirable to use holddown force as a control variable. For future reassemblies, it is recommended that flight-measured data such as the guidance-telemetered thrust velocity, CM101A acceleration and/or theodolite data be used to calculate holddown force.

7.8 FLIGHT CONTROL. Vehicle AC-6 was launched on a planned azimuth of 94.539 degrees true. A programmed positive roll of 20.461 degrees is required for this azimuth since the vehicle is initially aligned at an azimuth 115 degrees. The required roll rate is +1.5739 deg/sec based on rolling between T+2 and T+15 seconds. The actual roll rate from the reassembly is +1.5533 deg/sec, which is equal to a total roll through 20.193 degrees. The difference between the preflight and reassembly roll is well within the 3-sigma tolerance.

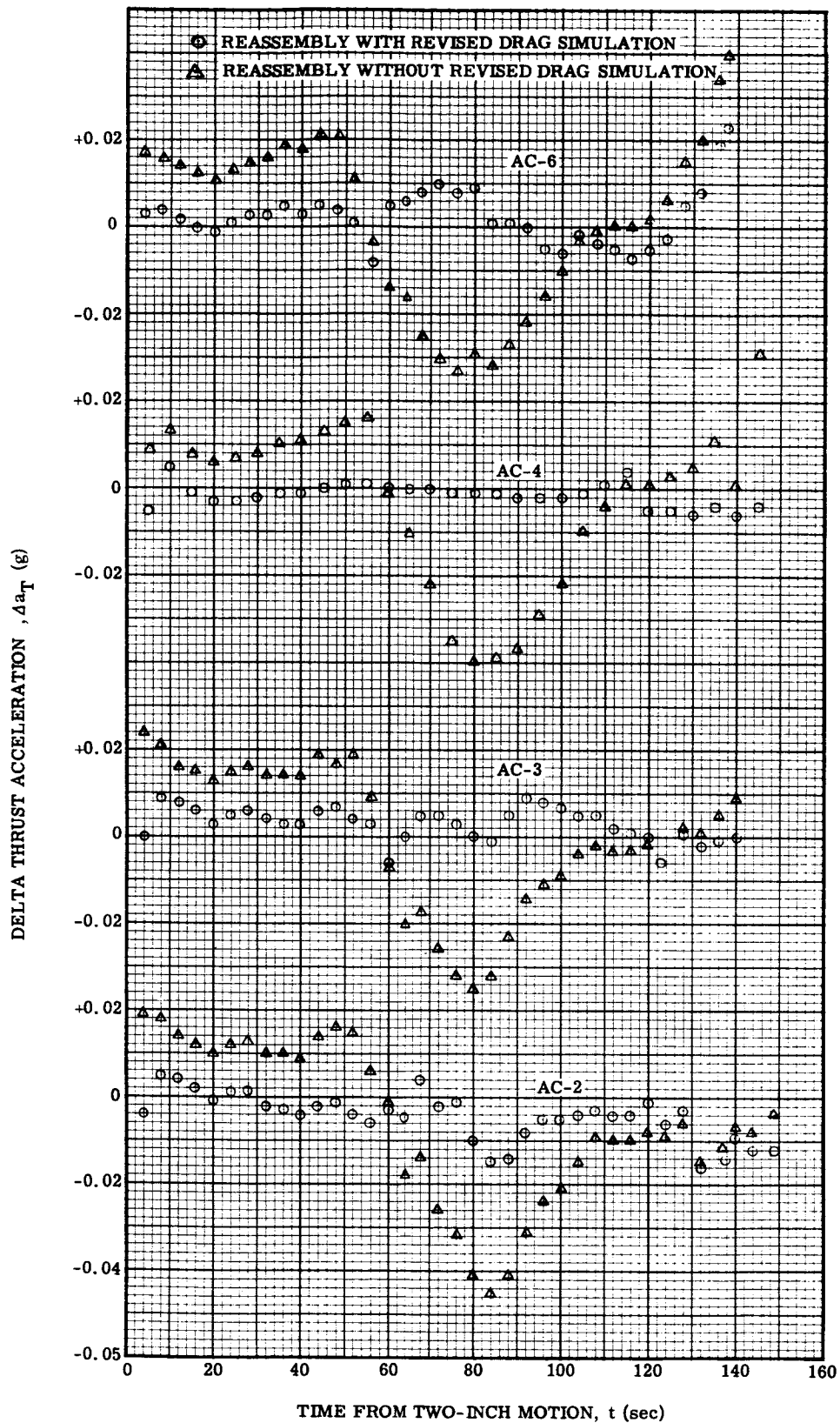


Figure 7-18. Acceleration Error Histories

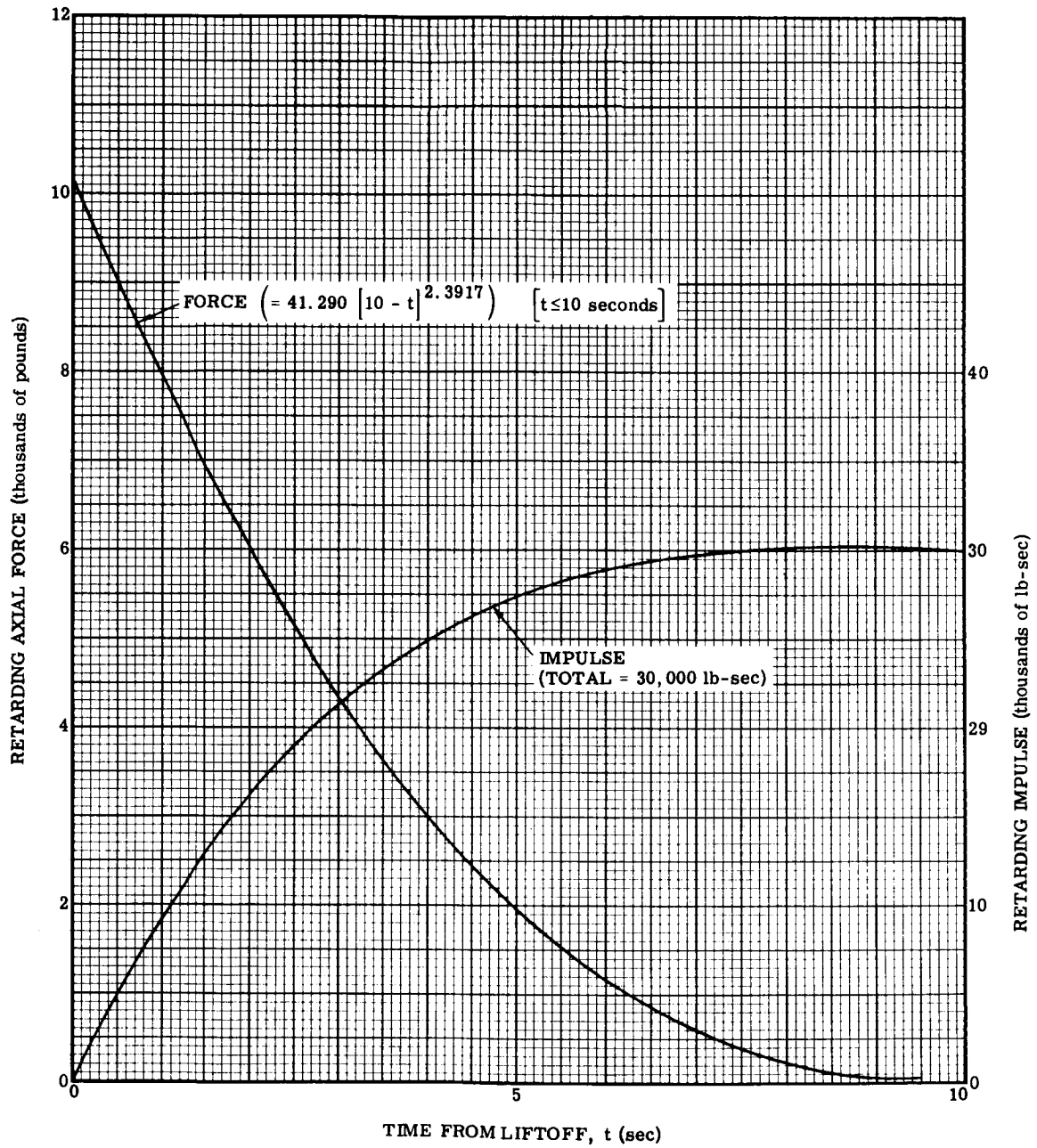


Figure 7-19. Holddown and Base Suction Force

During the phase from liftoff to booster engine cutoff, the autopilot provided pitch attitude control through a series of programmed constant pitch rates (pitch rate plateaus). Nominal and reassembly command pitch rate for vehicle AC-6 is shown in Figure 7-20. The reassembly was generated using the nominal command pitch rate modified by a constant pitch rate multiplier. The pitch multiplier (TLTX) required to give the best match of the guidance tracking data $TLTX = 1.0138306$, gives an effective pitch that is well within the 3-sigma pitch program tolerance of 5 percent. This was accompanied by a pitch drift of -0.00546 deg/sec (nose up) and a yaw drift of -0.0015 deg/sec (nose right). The overall effect was a pitch excess that reduced slightly the lofting on this flight. The inertial pitch attitude (ψ) of the reassembly was 0.133 degrees lower than the pre-flight inertial attitude at 140 seconds from liftoff.

The pitch attitude history, from liftoff to sustainer engine cutoff, is shown in Figure 7-21 for the preflight and reassembly trajectories. Also shown is pitch attitude from flight data determined from telemetered guidance computer thrust velocities. The reassembly match of the flight data is considered good. The existing differences are partly due to the fact that the trajectory is a steady-state simulation which does not simulate the transients of the autopilot. However, the primary reason is that the flight data is only an approximation of vehicle attitude, and it is in error due to the effects of engine gimbaling and aerodynamic forces.

The pitch and yaw steering signals to the autopilot, during the sustainer and Centaur phases, were generated by the Minneapolis-Honeywell all-inertial vehicle guidance set located on the Centaur stage. The vehicle guidance set is physically separated into five major packages:

- a. Inertial platform assembly
- b. Platform electronics package
- c. Computer
- d. Signal conditioner
- e. Pulse rebalance electronics, gyro torquer, and power supply package.

The attitude control provided by the Centaur guidance set was simulated in the reassembly using pitch-, yaw-, and roll-rate histories calculated from guidance computer telemetered thrust-velocity data. The pitch rates were determined every second by first differentiating the thrust-velocity components to obtain the accelerations along each axis of the U, V, W inertial axes system. Inertial attitude was then calculated, assuming the thrust axis (defined by the accelerational components) was aligned along the vehicle longitudinal axis. Pitch, yaw and roll rates were obtained by differentiating the inertial attitude history. In the reassembly, additive pitch and yaw rates were used as control variables to modify the pitch and yaw rates to obtain the best match. The additive pitch and yaw rates during the sustainer phase were -0.00585 and $+0.00119$ deg/sec respectively. During the Centaur phase, the pitch rate was $+0.000440$ deg/sec

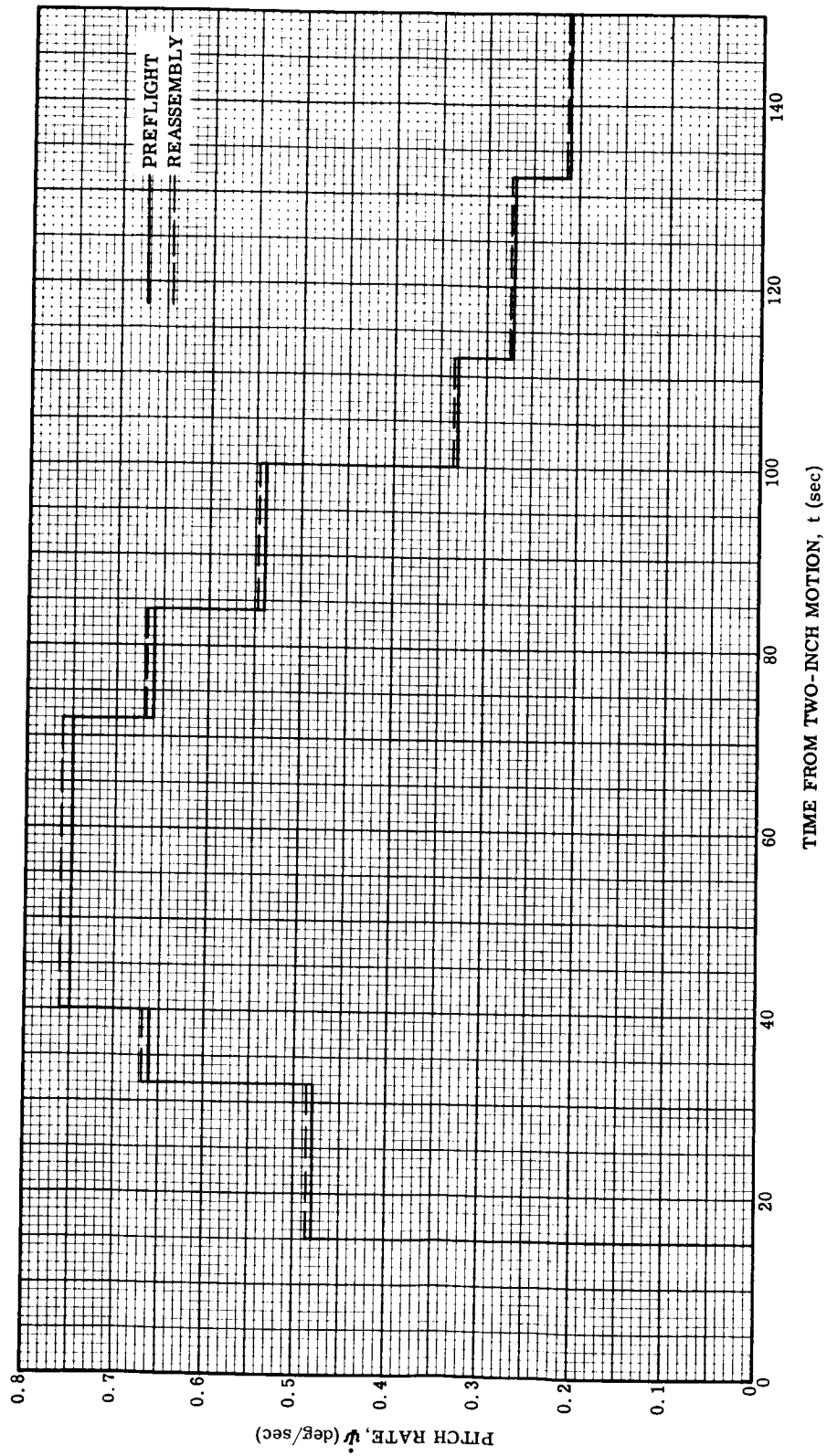


Figure 7-20. Nominal Pitch Rate as a Function of Time, Atlas Stage

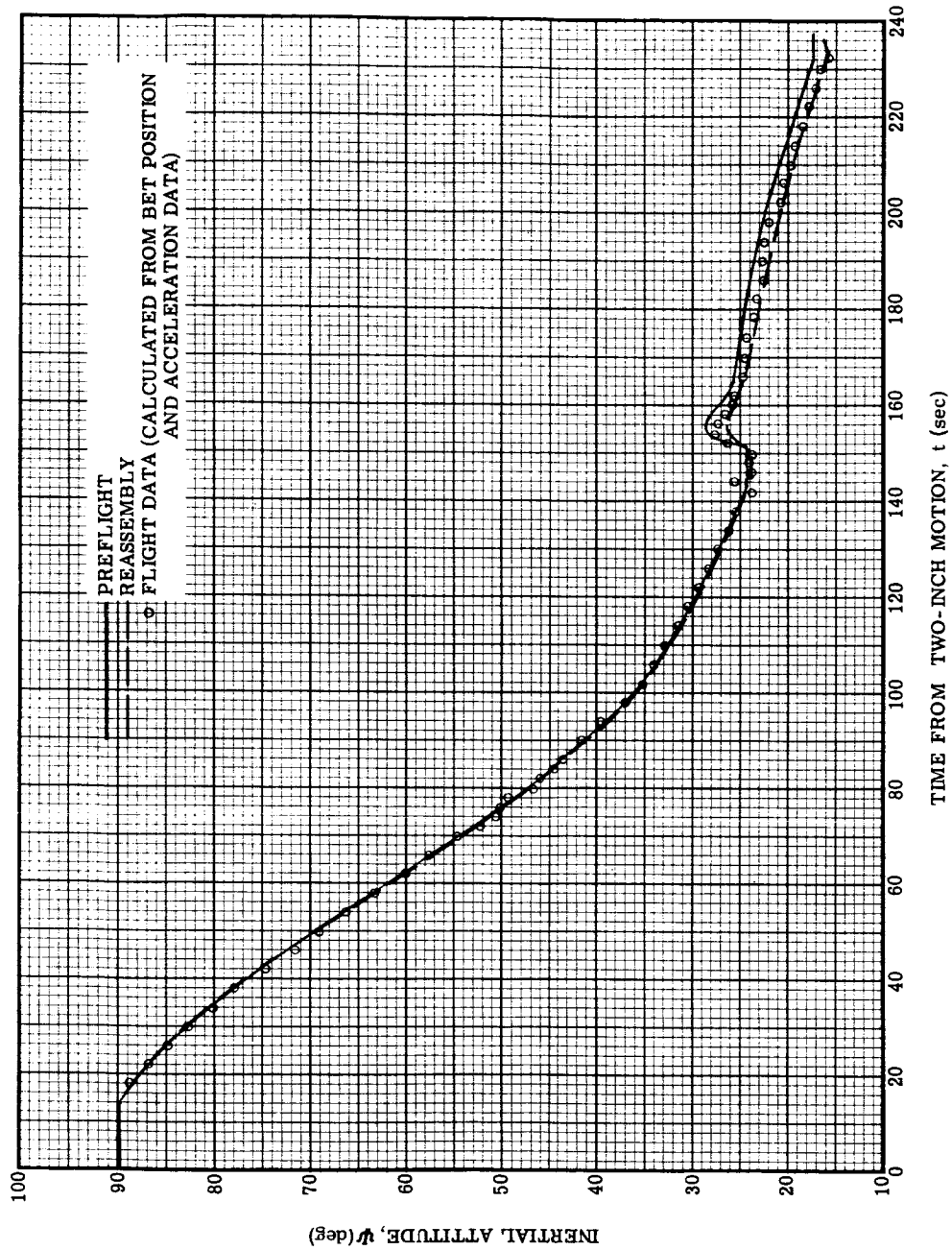


Figure 7-21. Inertial Attitude as a Function of Time, Atlas Stage

and the yaw rate was -0.000249 deg/sec. Minus signs denote nose up for pitch rate and nose right for yaw rate.

Initial errors in inertial attitude were also modified for the sustainer and Centaur phases. The initial error for the sustainer phase was 0.619 degree in pitch and 0.586 degree in yaw. The initial error for the Centaur phase was -2.12 degrees in pitch and -1.414 degrees in yaw. Pitch attitude in the Centaur stage was also modified -0.0666 degree at admit-guidance-perigee-altitude-control time. The resulting pitch attitude history for the sustainer phase together with the booster phase history is presented in Figure 7-21. The Centaur pitch attitude history is presented in Figure 7-22.

7.9 SPACECRAFT SEPARATION AND CENTAUR RETROMANUEVER. Table 7-11 defines the planned and actual orbits of the AC-6 Centaur tank after the retromaneuver. The "actual" tank orbit was determined from the reassembly, which simulated the turnaround and blowdown. The turnaround was simulated by reorienting the Centaur to an attitude vector defined by guidance 560 seconds after booster engine cutoff. The blowdown was determined by simulating flight-derived (by Centaur Thermodynamic Group) blowdown-phase thrust and flow rates.

This is the best known solution available for defining the orbit of the Centaur tank. Of the two C-band radar sites tracking the tank after the retromaneuver, neither Pretoria nor Ascension yielded any data satisfactory for an orbit determination. The guidance data, which evidently are in error (Section 4), are available only up to 1758 seconds from 2-inch motion (96 seconds prior to the end of the retromaneuver). The predicted and flight blowdown thrust and flow rates are compared in Figure 7-23. Separation distance between the spacecraft and tank five hours after spacecraft separation from Centaur was 1966 km based on the reassembly simulation. The preflight predicted separation distance was 2177 km.

7.10 ENVIRONMENT

7.10.1 Atmosphere. Figures 7-24 and 7-25 present ambient pressure and velocity of sound data used for the reassembly trajectory. The atmosphere data were obtained from a Cape Kennedy Rawinsonde run (balloon released approximately 9 minutes after two-inch motion).

7.10.2 Wind Profile. Figure 7-26 presents the wind profile used for the reassembly trajectory. The postflight wind data was obtained from the same Rawinsonde run as that used for the atmospheric data.

7.10.3 Geodetic Data. The geodetic data used for the vehicle AC-6 trajectory reassembly is identical to that used in the preflight simulation. Details of these data are presented in Reference 2.

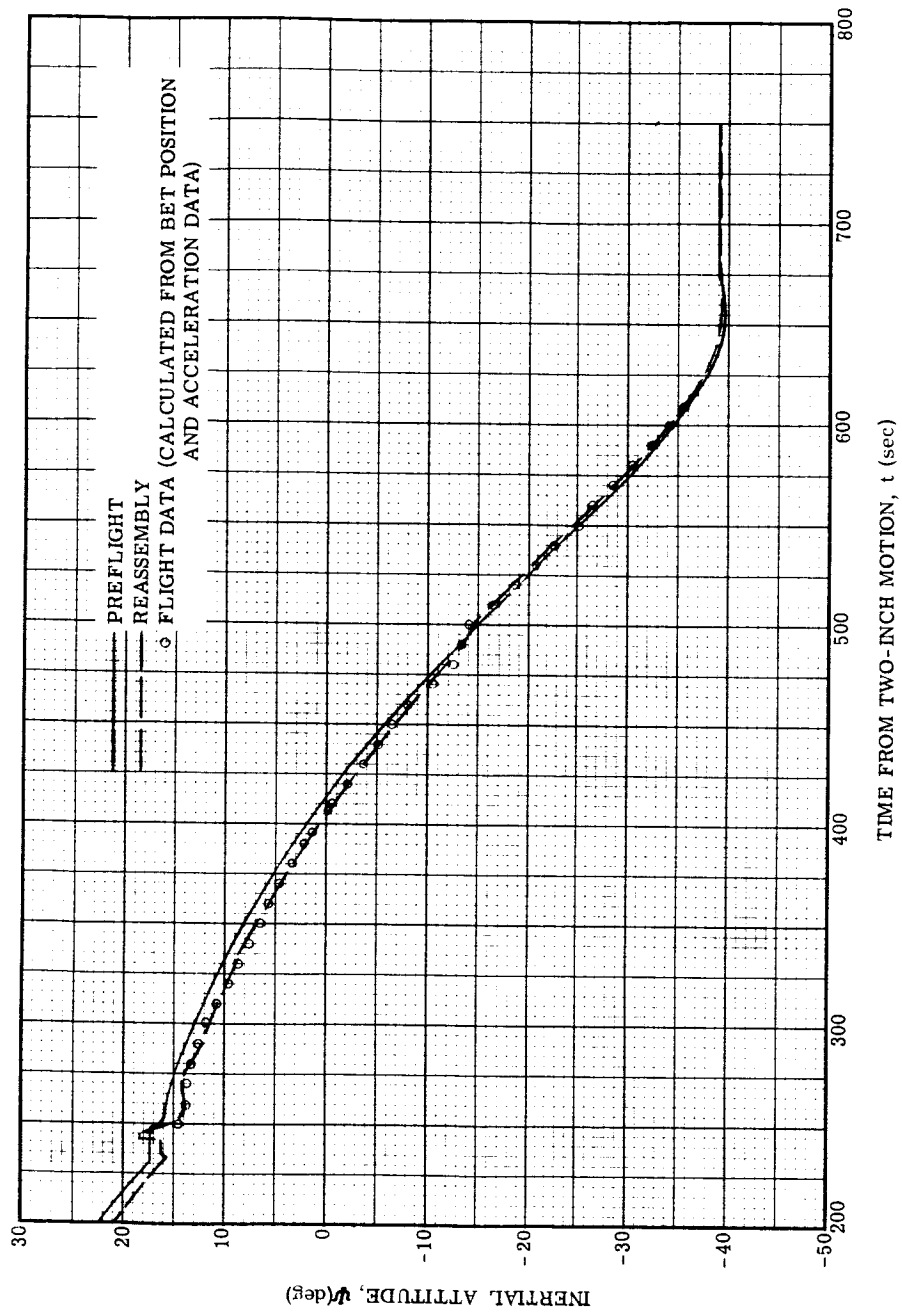


Figure 7-22. Inertial Attitude as a Function of Time, Centaur Stage

Table 7-11. AC-6 Centaur Tank Orbital Parameters

PARAMETER	PREFLIGHT	REASSEMBLY
Radius (ft)	21,473,358	21,473,298
Latitude (deg)	20.840167	20.872337
Longitude (deg)	313.88940	313.89464
Earth Relative Velocity (fps)	34,701.004	34,693.655
Pitch Angle (deg)	0.48466168	0.40891488
Azimuth (deg)	110.86321	110.77196
Semimajor Axis (ft)	1,426,599,100	1,358,208,800
Eccentricity	0.98494887	0.98419073
Inclination (deg)	28.595885	28.559768
C_3 (ft ² /sec ²)	-9,867,200.4	-10,364,047.0
Longitude of Ascending Node (deg)	358.92263	359.10143
Argument of Perigee (deg)	131.04756	131.02614
True Anomaly (deg)	0.93960006	0.79304000

Note: Data epoch is end of Centaur retromaneuver

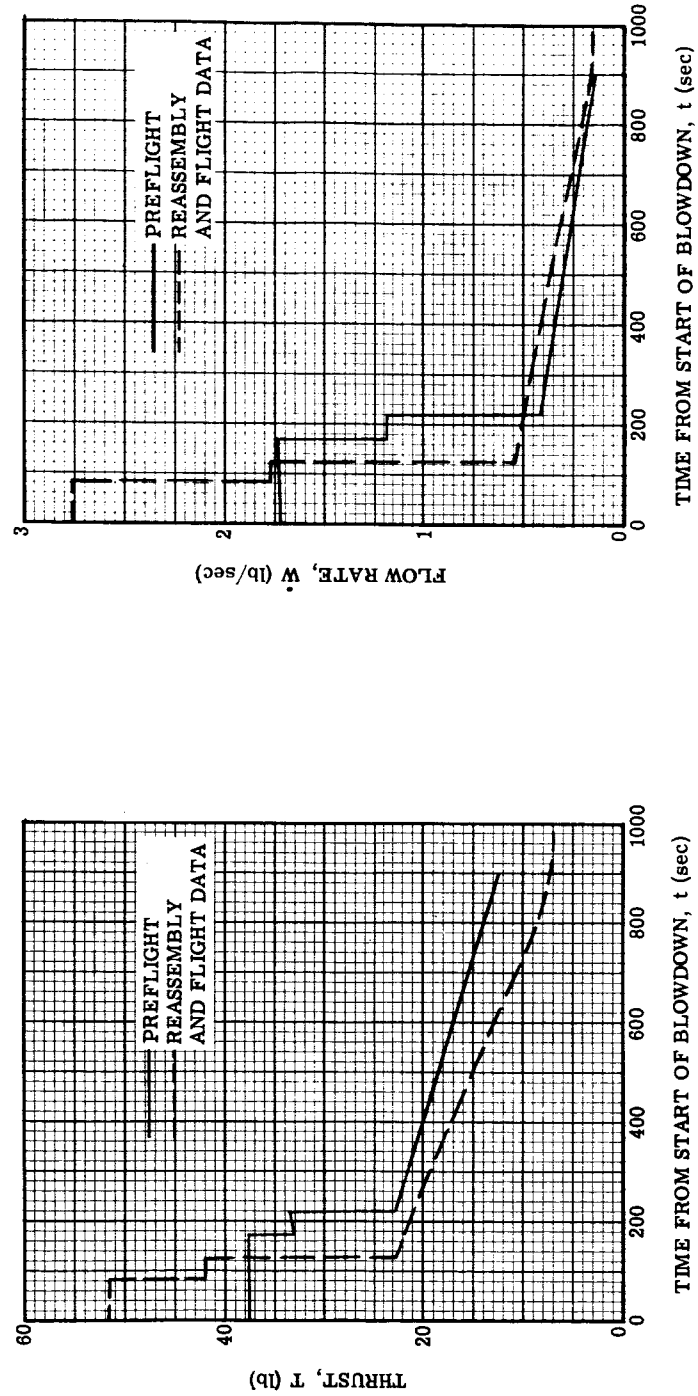


Figure 7-23. Thrust and Flow Rate During Centaur Retromanuever Blowdown Mode

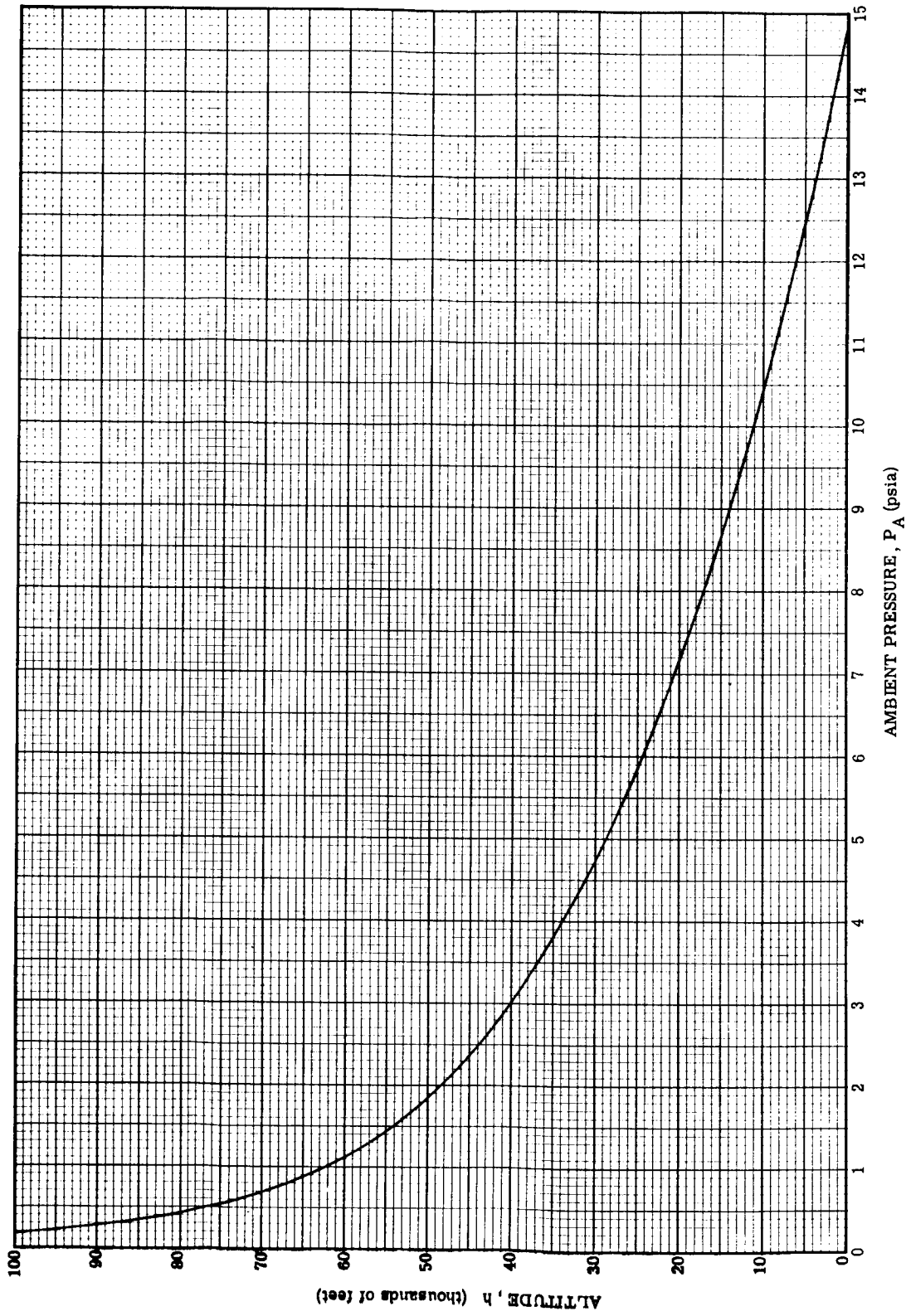


Figure 7-24. Ambient Pressure as a Function of Altitude

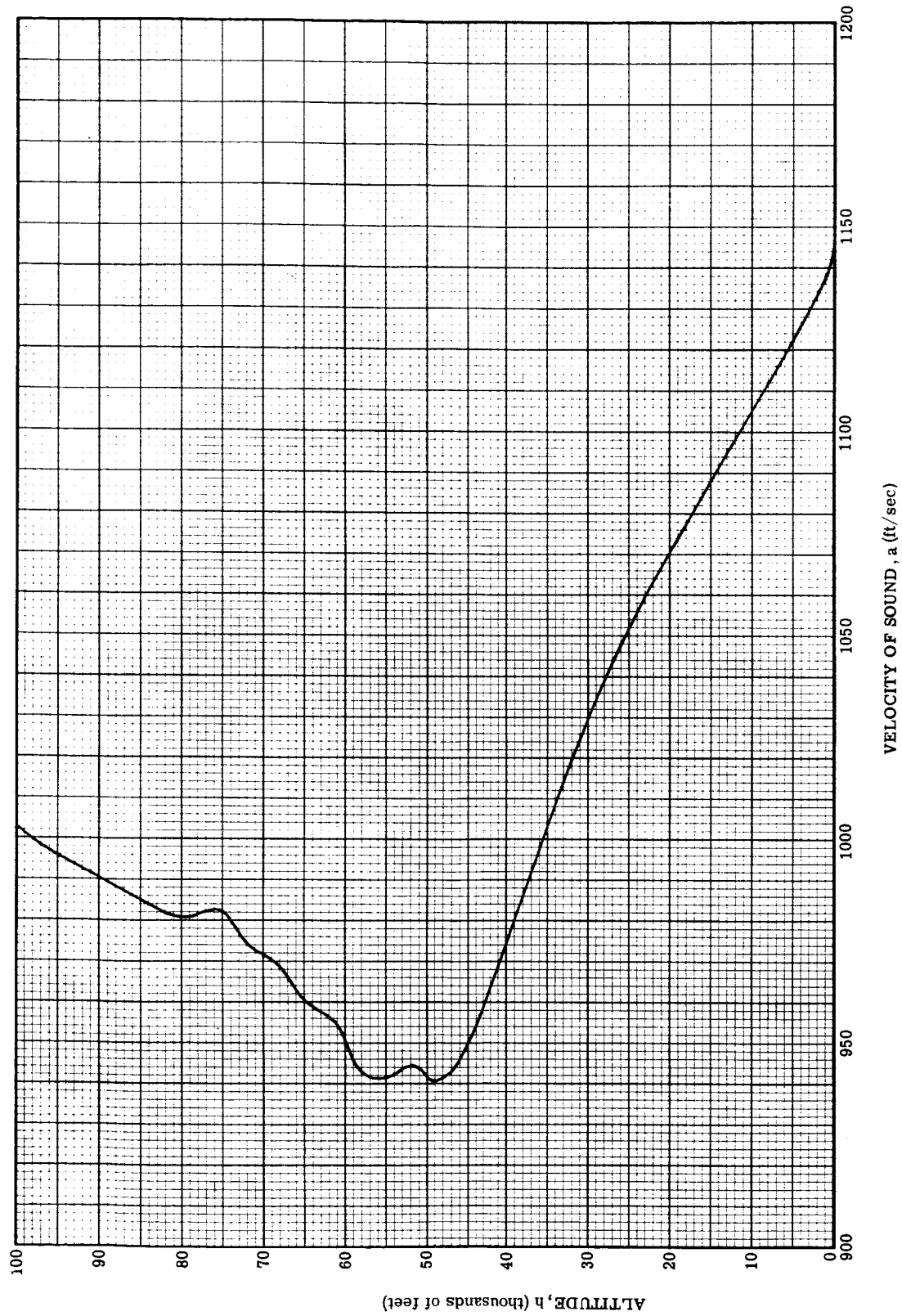


Figure 7-25. Velocity of Sound as a Function of Altitude

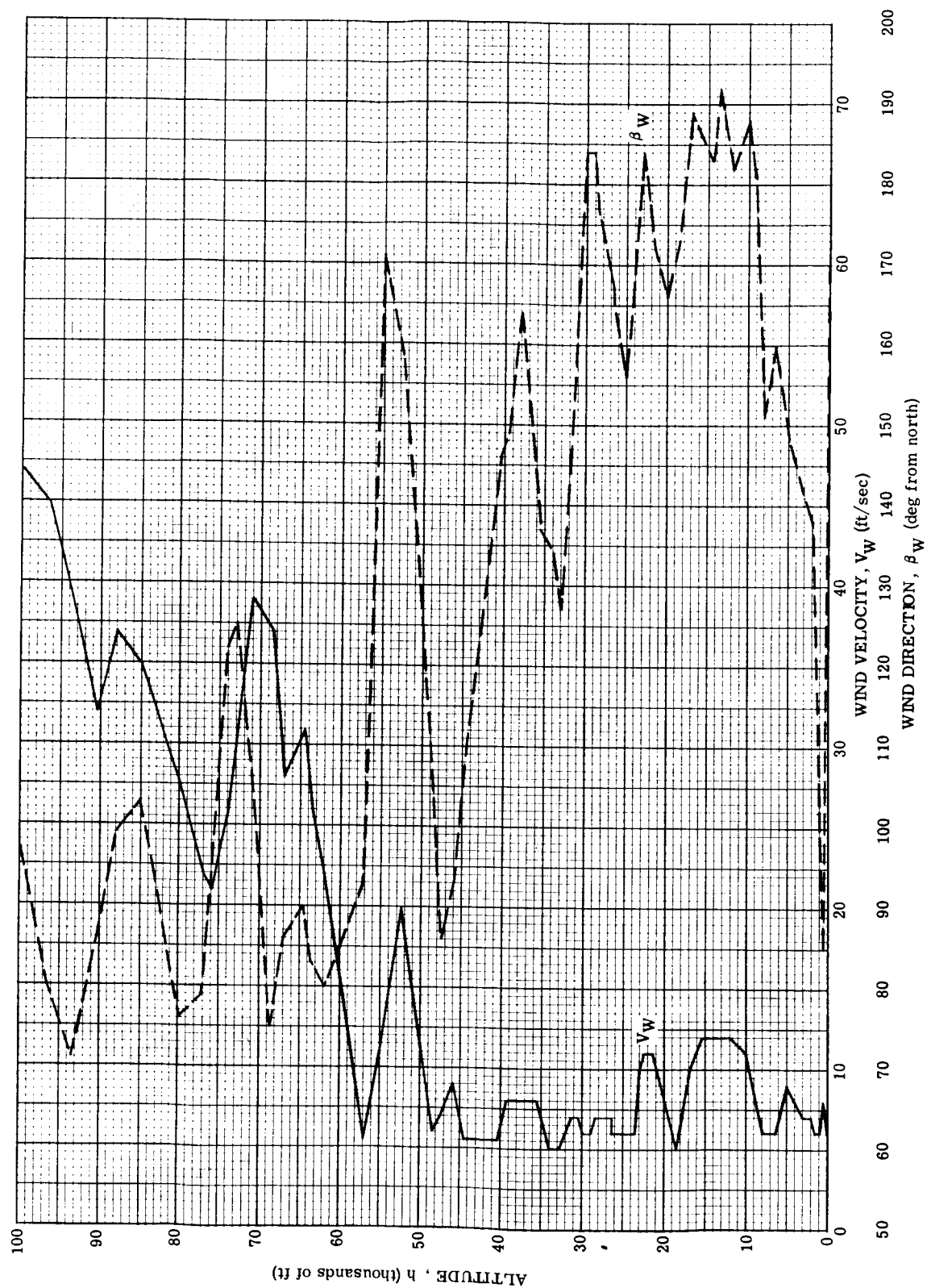


Figure 7-26. Wind Direction and Velocity as a Function of Altitude

SECTION 8

CONCLUSIONS AND RECOMMENDATIONS

On the basis of the vehicle AC-6 reassembly, the following conclusions and recommendations may be made concerning vehicle configuration and system performance during flight.

- a. Booster engines thrust was 1106 pounds (0.29 percent) higher than preflight predicted; sustainer thrust was 1449 pounds (2.54 percent) higher than preflight predicted. Booster engines specific impulse was 2.47 seconds (0.85 percent) low, and sustainer-plus-vernier specific impulse was 4.1 seconds (1.91 percent) high compared to the preflight predictions.
- b. The use of preflight booster decay and iterating on booster-engine start-of-decay time was found to give unsatisfactory results. Decay characteristics determined using the CM101A acceleration data in conjunction with guidance acceleration data are considered to yield accurate results; in future reassemblies it is proposed that these data be used rather than iterating on stage time.
- c. Booster engine cutoff (BECO) occurred 1.473 seconds early. This error is attributed primarily to higher-than-nominal booster and sustainer thrust, lower-than-nominal booster engine I_{sp} , and the unrevised drag model that was used in the preflight simulation.
- d. The AC-6 sustainer engine decay (sustainer staging on propellant depletion) was significantly different than the preflight-predicted. The decay occurs in 1.3 seconds compared to 2.9 seconds as predicted in the preflight simulation. The start of the decay occurs at nearly the same propellant weight; thus, the shorter decay time results in propellant residuals of 322 pounds in excess of those predicted. The payload loss thus incurred is 36 pounds. To reduce this cutoff error between predicted and actual, the decay model is being re-evaluated by Rocketdyne.
- e. On the basis of (a) through (d), it is concluded that the booster, sustainer, and soft-decay propulsion simulations need improvement. It is recommended that the present efforts to improve the engine model be continued until these and any other associated problems are resolved. Special emphasis should be placed on the soft-decay model since it is obviously in error and causes a payload loss of 36 pounds.
- f. The Atlas booster-phase pitch program was close to nominal. The inertial pitch attitude (ψ) was 0.133 degrees lower than the preflight inertial attitude at 140 seconds from liftoff.

- g. The revised drag simulation that has been accepted for future simulations made a significant improvement in the position and velocity match during the Atlas phase of flight.
- h. The holddown force determined in the reassembly is 38.6 percent of that determined for AC-4. For future reassemblies, it is recommended that flight-measured data such as the guidance-telemetered thrust velocity, CM101A acceleration, and/or theodoilte data be used to calculate holddown force.
- i. The Centaur attitude, as determined by the Centaur guidance system, was close to nominal. However, the technique used to simulate the Centaur guidance system in the reassembly does not yield values of specific guidance parameters. These parameters are determined by the Centaur Guidance Analysis Group and are published in Reference 6.
- j. The Centaur engine system performance was below nominal. The Centaur main engine thrust was 29,525 pounds (the mean thrust with PU valve at a null position). This is 1.7 percent low. Centaur main engine specific impulse (mean value with PU value at null position) was 1.3 seconds (0.3 percent) low. It is recommended that a method of simulating the engine/PU system be developed and used in the reassembly and the preflight simulation. This would not only improve the reassembly trajectory simulation but would improve the preflight trajectory simulation and would lead to a more realistic comparison of Centaur engine system performance in the future.
- k. Centaur main engine burn time was 4.94 seconds longer than predicted. The longer burn time was due to lower-than-predicted main engine thrust.
- l. The calculation of I_{sp} by curve fitting thrust acceleration (Reference 14 and 15) gave erroneous answers for both the sustainer and Centaur stages because the assumption of constant thrust and flow rate was violated. It is recommended that in future Atlas/Centaur reassemblies this method should not be used unless the thrust and flow rate can be shown to be constant over the span of the curve fit. Extreme care must be used, since the slightest variation in thrust has a significant effect on the I_{sp} thus calculated.
- m. The payload capability, calculated using flight-determined residuals, is 20 pounds greater than the predicted mean payload capability.
- n. The blowdown performed satisfactorily and provided a separation distance of 1966 km between the spacecraft and tank 5 hours after spacecraft separation from Centaur. The preflight-predicted separation distance was 2177 km.
- o. The best known solution for the Centaur tank orbit was determined from the trajectory reassembly.

SECTION 9

REFERENCES

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16. R. G. Frayer, Atlas Base Drag Study, Convair Division Report GDC-BTD65-089, 1 June 1965 (Unclassified)
17. T. Chacon, Distributions and Total Vehicle Aerodynamic Coefficients for the Atlas/Centaur-Surveyor Vehicle, Convair Division Report GDC-BTD66-027, (to be published, Unclassified)

APPENDIX A PREFLIGHT TRAJECTORY LISTING

The first 5 pages of the IBM trajectory listing present the various input quantities that define the trajectory, computation sequence, weights, propulsion data, etc. The trajectory listing is divided into sections that correspond to contiguous flight phases:

<u>SECTION</u>	<u>TRAJECTORY EVENT</u>	<u>STAGE</u>
1	Guidance-to-Inertial	Atlas
2	Liftoff (2-Inch Motion, $t = 8$ sec)	
3	Booster jettison	
4	Atlas sustainer jettison	
5	Main engine ignition	Centaur
	Centaur main engine cutoff and decay, space-craft separation, and orbit injection	

A description of the trajectory parameters is presented in Appendix C.

CCC = 1 , 1 , 30H COMBO SECTION 1 DATA *

8 SECOND PRELAUNCH PHASE

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CCC = 3 , 1 , 3CH DEPRO INITIAL CONDITIONS DATA *
PU = .20000000+1, .10000000+1, .      + , .
PU=6.,
```

165 K PITCH PROGRAM OCTOBER 23, 1963 REVISION 2

BXTEN=	14.				
BXMR=	1.98	2.00	2.05	2.10	2.15
	2.20	2.28	2.30	2.35	2.40
	2.45	2.50	2.55	2.58	
BXDT=	-157.6	-137.0	-86.6	-515.0	-276.0
	-117.0	0.0	-12.0	-42.0	-165.0
	-187.0	-293.0	-416.0	-499.0	
BXDWF =	0.9490	0.8060	0.5230	0.3120	0.1670
	0.0760	0.0	0.0071	0.0255	0.0636
	0.1132	0.1770	0.2520	0.3020	
BXDWD=	2.2350	1.9000	1.2320	0.7330	0.3930
	0.1670	0.0	0.0167	0.0599	0.1500
	0.2660	0.4160	0.5930	0.7100	
SXTEN=	16.				
SXMR=	1.90	1.95	2.00	2.05	2.10
	2.15	2.20	2.27	2.30	2.35
	2.40	2.45	2.50	2.55	2.60
	2.65				
SXDT=	-327.1	-241.2	-171.8	-117.6	-77.7
	-63.6	-16.5	11.6	18.2	13.2

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 -68.1, -67.0, -67.5, -67.8, -65.9, -63.4, -62.3,
 -61.1, -61.2, -60.8, -59.9, -59.2, -57.5, -56.1,
 -56.6, -55.3, -54.7, -53.2, -52.0, -51.1, -50.1,
 -49.4, -49.8, -50.2, -50.8, -50.6, -50.2, -50.8,
 -50.5, -50.5, -49.3, -48.8, -48.0, -46.7, -46.6,
 -46.0, -45.6, -44.7, -43.9, -43.5, -44.3, -44.2,
 -43.4, -42.2, -41.3, -40.1, -39.2, -38.8, -38.5,
 -37.1, -35.7, -34.5, -32.5, -30.6, -28.6, -26.6, -24.6,
 -22.6, -20.6, -18.6, -16.6, -14.6, -12.6, -10.6, -8.6,
 -6.6, -4.6, -2.6, -0.6, 0.0, 0.0, 0.0, 0.0, 0.0,
 RHOMT =
 1159.02, 1159.02, 1135.68, 1105.31, 1074.71, 1046.08, 1018.19,
 989.67, 961.36, 934.55, 905.42, 877.50, 851.06, 826.40,
 801.64, 777.41, 754.17, 731.46, 709.12, 689.39, 663.85,
 641.85, 621.05, 602.33, 582.82, 564.13, 545.45, 528.23,
 511.26, 495.15, 479.22, 464.31, 450.11, 436.45, 420.33,
 406.42, 392.23, 380.21, 367.57, 355.14, 343.13, 331.82,
 320.14, 308.56, 296.32, 284.90, 273.59, 263.24, 251.71,
 241.96, 229.44, 215.64, 205.50, 194.58, 185.30, 176.46,
 168.30, 159.17, 151.75, 144.51, 136.18, 128.02, 121.28,
 114.83, 109.39, 103.98, 98.67, 93.67, 88.58, 83.89,
 80.10, 75.98, 72.27, 68.49, 65.00, 61.79, 58.72,
 55.90, 53.46, 51.14, 48.96, 46.69, 44.49, 42.60,
 40.61, 38.77, 36.83, 35.10, 33.40, 31.72, 30.30,
 28.88, 27.54, 26.22, 24.99, 23.84, 22.87, 21.86,
 20.83, 19.81, 18.87, 17.97, 17.12, 16.36, 15.63,
 14.88, 14.16, 13.15, 12.15, 11.15, 10.15, 9.15, 8.15, 7.15,
 6.15, 5.15, 4.15, 3.15, 2.15, 1.15, 0.15, 0.00, 0.00,
 * CCC = 9.150H JETTISON NOSE FAIRING AND INSULATION PANELS *
 SK = 3, 3,
 ST = 26.9, 51.9,
 SW = 1225., 2005.,
 *
 CCC=2.38*
 TIME1 = 0., 100.,
 WDOT1 = 4.44, 4.44,
 TMST1 = 8.72, 8.72,
 TIME2 = 1., 2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12., 13., 14., 15., 16., 17.,
 18., 19., 20., 1000.,
 TMST2 = 6.72, 618.72, 2008.72, 2008.72, 2708.72, 2308.72,
 2608.72, 3208.72, 4608.72, 12878.72, 31878.72, 31208.72,
 3408.72, 29608.72, 28608.72, 28808.72, 29408.72, 29708.72,
 2996.72, 30008.72, 30008.72, 30008.72,
 WDOT2 = 8.903, 8.303, 9.503, 9.103, 8.703,
 10.103, 12.103, 12.703, 15.103, 28.503,
 56.313, 64.903, 64.103, 73.703, 75.103,
 70.503, 72.503, 72.103, 71.303, 70.103,
 69.387064, 69.384064,
 TIME3 = 0., C-16, C-1600001, 124.99999, 125., 299., 301., 344., 345.,
 1020.,
 1020., 2000.,
 TMST3 = 0., -0.62401242-1, 0., 0., -37.4, -37.7, -33., -33.6, -22.9,
 -12.3, 0., 0.,
 WDOT3 = 0., 0., 0., 0., 1.725, 1.742, 1.179, 1.170, 0.405, 0.140, 0.00.,
 *
 CCC=4.1*
 RLIN= 0., 1., 2., 1., 1.,
 GLK(1)=6., GLK(4)= 20., GLK(5)= 4.,
 GLK(3)=8., GLK(4)= 0., GLK(5)= 4.,
 E(1) = 5.9, 550., 630.,
 E(4) = .10+5, .40+5, .20+4, .03,

E(18) = 1.9 , .C07 , 350.0 , 100. , .280+08,
 E(13)=1500.,
 E(14)=560.,
 E(15)= 5.9,
 I(1) = .12966541+4, .34743744+3, -.322+2,
 I(4) = .1546647+5, -.56751978+5, .20909816+8,
 I(7) = .322+2, .35+5, .1342+4, .30+5,
 K(1) = .14C76539+17,
 K(2) = 23.5 , -.0.99,
 K(4) = C.21866848+08, -0.31678034+07, C.18143634-01, -0.99673504-01,
 K(8) = 0.5581C664+07,
 K(9) = C.24877091-06, -C.43310611-03, -0.19070706-12,
 K(12) = 0.17473147+05, C.36279207+04, -C.75538885-05, 0.12388931-03,
 K(16) = C.623501C4+04,
 K(17) = .15, K(18) = .4092590C, K(19) = .0013 , K(20) = 3600.,
 K(19) = .0013,
 K(21) = -4.,
 K(22) = .30076330-C1, .24078853, -.10643349+01,
 K(25) = .9C462493, .27728184, -.21241567+02, .10957065+03,
 K(29) = .131C2096+03, .10638315+03, -.32799193+02, .11120200+03,
 K(31) = 8-8,
 K(34) = .9-03,
 K(99) = .4,
 K(100) = .1-31,
 K(101) = 1., .75,
 K(103) = -.01 , .035 , .005 ,
 D(1) = 1., 1., 1.,
 I(1) = .12166588+04, .56733731+03,
 I(4) = .24823368+05, -.53233885+05,
 I(1) = -32.2, 32.2, 1342., .355+5, 3C+5, .209C9816+8,
 K(19) = -.00175,
 J(42) = 1216.6588, 567.33731, 24823.368, -53233.885,
 PRIFLG = 1.,
 *
 CCC = 4, 1, 50H GUIDANCE INPUT
 J(1) = -C.40369C16-00, C.46247C85-04, C.1C266958-08, -0.54328343-13,
 J(5) = -C.30314729-17,
 J(8) = -C.16857181-00, C.3838C385-04, -C.88343719-09, -0.38656905-13,
 J(10) = 0.37732661-17,
 J(11) = -0.1155335C+08, C.17431387+03, -C.52038705-01, -0.63366950-07,
 J(15) = -0.95482014-10,
 J(16) = 0.3C4486C1-01, C.67576705-04, -0.11558225-08, -0.174C7320-13,
 J(20) = -C.146C1112-16,
 J(21) = -C.27289493+04, 0.11666372+01, -C.5C387756-05, -0.38196332-09,
 J(25) = -0.28127520-12,
 J(26) = C.13222177+01, -0.1869C193-03, C.18831933-07, -0.70701808-12,
 J(30) = -C.11843472+06, J(31) = 0.54596564-02,
 J(32) = 0.21793736+08, -0.12573355+03, 0.13966911-01,
 J(35) = C.20677527+05, C.3402088C-00, -0.5C872056-04,
 J(38) = C.36615446+03, -0.46536C56+00, C.67611214-04,
 *
 CCC=0.0* TSUBL = 52256.43, ID = 12H-6 NOM , *
 CCC=2.30* TRDLR = C., 1.573906, *
 CCC=4.1* J(41) = -715.46,*
 CCC=C,0,/

CASE 1		TRAJECTORY ID -6 NOM					SECTION 1				PAGE 1		
TIME	LONGITUDE	ALTITUDE	VELOCITY RA	FLT PATH R	VELOCITY I	FLT PATH I	AXL FORCE	VEL R AZ	AXL LD FCTR	NORM FORCE	ALPHA	RETA	DYNN PRS
GEOCENT LAT	R MAGNITUDE	THRST FIXED	PITCH ATT	WEIGHT	WEIGHT DOT	MACH NUMBER	SIDE FORCE	RETA	REV NUMB	ATM PRS	REV NUMB		
ENGLISH UNITS													
-0.	0.	0.	-0.01C38	1342.434	-0.	0.	88.437	0.					
279.4588	2C909901.00	0.	89.98788	303510.000	0.99851	0.	0.	0.					
28.3C75	0.09	0.	C.00333	0.	0.	0.	0.	0.					
1.0000	0.	0.	-0.04423	1342.434	-0.	0.	88.439	0.					
279.4588	2C909901.00	0.	89.98436	303510.000	0.99851	0.	0.	0.					
28.3075	0.09	0.	C.00333	0.	0.	0.	0.	0.					
5.0000	0.	0.	-0.16226	1342.434	-0.	0.	94.456	0.					
279.4588	2C909901.00	0.	89.96951	303510.000	0.99851	0.	0.	0.					
28.3075	0.08	0.	0.0C333	0.	0.	0.	0.	0.					
8.0000	0.	0.	-0.30312	1342.434	-0.	0.	88.454	0.					
279.4588	2C909901.00	0.	89.95862	303510.000	0.99851	0.	0.	0.					
28.3C75	0.14	0.	C.00333	0.	0.	0.	0.	0.					
8.0000	0.	0.	-0.30312	1342.434	-0.	0.	88.454	0.					
279.4588	2C909901.00	0.	89.95862	303510.000	0.99851	0.	0.	0.					
28.3075	0.14	0.	C.00333	0.	0.	0.	0.	0.					

CASE 1	TRAJECTORY ID	-6 NOM	SECTION 2	PAGE 16
0.	0.3637810+01	0.37062991+04	0.22164804+C6	0.76448154+00
0.32999999-00	0.83144001-C2	0.15163583+C4	0.34019436+05	0.28552970-00
0.	0.2345211-C1	0.1877920+C4	0.20992784+C8	0.57796089+C0
0.31555834+03	0.31595834+03	0.28636745+C0	0.80544850+00	0.44537210-00
0.13599617-07	0.6524130+C8	0.14113345+C3	0.2977477+C3	0.31798379+C4
1	0.7310910+02	0.22452339+C0	0.12790728+C4	0.26960472+05
2	0.5613635+02	0.59673229+C0	0.60323334+02	0.50379999+02
3	0.39612231+03	0.68295048+C3	0.80983936+C2	0.18826466+C3
4	0.1452988+03	0.28059772+C0	0.33119544+01	0.15046625+C5
5	0.5950000+02	0.3621886+C0	0.3190030+C2	0.35814287+C0
6	0.8115802+01	0.17332696+C2	0.69106001+02	0.37700000+02
	112.0000	87959.50	3475.690	35.19454
	279.6794	20957874.25	81409.830	34.64725
	28.2941	11.69	369845.816	0.33000
0.	0.31171089+C1	0.38564887+C4	0.22921002+C6	0.77066773+C0
0.32999999-00	0.97575654-C2	0.15732286+C4	0.37108701+C5	0.28783953-C0
0.	0.30741064-C1	0.19296566+C4	0.20996591+C8	0.56852237+C0
0.32064492+03	0.32064492+C3	0.29006003+C4	0.81431324+C0	0.45367002-C0
0.12956434+C7	0.67898849+C8	0.14146867+C3	0.29083863+C3	0.32213196+C4
1	0.74819807+C2	0.22485676+C1	0.12797798+C0	0.26937032+C3
2	0.56045089+C2	0.66509653+C2	0.60325737+C2	0.66791286+C2
3	0.3962260+03	0.98375727+C3	0.80849256+C2	0.18852107+C3
4	0.15221659+C0	0.22042918+C0	0.35885837+C1	0.14535599+C5
5	0.5950000+C2	0.36882639+C2	0.31182254+C2	0.29961572-C0
6	0.80683839+01	0.17197161+C2	0.67200001+C2	0.37400001+C2
	114.0000	91961.25	3639.024	34.41025
	279.6972	21001877.25	81497.617	33.98725
	28.2929	12.62	370153.754	0.33000
0.	0.3159893+C1	0.40119506+C4	0.23707752+C6	0.77675166+C0
0.32999999-00	0.97573517-C3	0.16316397+C4	0.40313350+C2	0.29011116-C0
0.	0.30621981-C1	0.19813377+C4	0.21000502+C8	0.55900641+C0
0.32482450+03	0.32482450+C3	0.29362969+C4	0.83089715+C3	0.46923018-C0
0.12289459+C7	0.70421984+C8	0.14175470+C3	0.29095122+C3	0.32619523+C4
1	0.76376963+C2	0.22518477+C1	0.12805200+C4	0.26939193+C3
2	0.5558607+C2	0.61356787+C2	0.60336662+C2	0.67713059+C2
3	0.39592117+C3	0.88455893+C3	0.80709422+C2	0.18868151+C3
4	0.15885088+C3	0.30886222+C1	0.37680151+C1	0.14024800+C5
5	0.5950000+C2	0.31127454+C2	0.31377250+C2	0.24975615-C0
6	0.80162584+C1	0.17648822+C2	0.65330001+C2	0.37100000+C2
	116.0000	96076.25	3824.434	33.66779
	279.7160	21005994.00	81572.605	33.32725
	28.2916	13.63	370438.785	0.33000
0.	0.32846372+C1	0.41728967+C4	0.24526148+C6	0.78273252+C0
0.32999999-00	0.97522586-C3	0.16916171+C4	0.43636274+C5	0.29234430-C0
0.	0.35321614-C1	0.20346646+C4	0.21004517+C8	0.56942027+C0
0.32849529+C3	0.32849529+C3	0.29718165+C4	0.85583612+C0	0.49267530-C0
0.11827344+C7	0.72827568+C8	0.14211398+C3	0.29105131+C3	0.33011676+C4
1	0.77938876+C2	0.22549310+C1	0.12812685+C4	0.26934414+C3
2	0.55871397+C2	0.62211000+C2	0.60349817+C2	0.68629831+C2
3	0.39581957+C3	0.88544911+C3	0.80569245+C2	0.18877489+C3
4	0.16157083+C3	0.32321618+C1	0.38741213+C1	0.13514176+C5
5	0.5950000+C2	0.31357458+C2	0.31555252+C2	0.20756638-C0
6	0.79557316+C1	0.16879551+C2	0.63400000+C2	0.36800000+C2
	116.0000	96076.25	3824.434	33.66779
	279.7160	21005994.00	81572.605	33.32725
	28.2916	13.63	370438.785	0.33000

CASE 1	TRAJECTORY ID	-6 NOM	SECTION 2	PAGE 17
0.	0.3637810+01	0.37062991+04	0.22164804+C6	0.76448154+00
0.32999999-00	0.83144001-C2	0.15163583+C4	0.34019436+05	0.28552970-00
0.	0.2345211-C1	0.1877920+C4	0.20992784+C8	0.57796089+C0
0.31555834+03	0.31595834+03	0.28636745+C0	0.80544850+00	0.44537210-00
0.13599617-07	0.6524130+C8	0.14113345+C3	0.2977477+C3	0.31798379+C4
1	0.7310910+02	0.22452339+C0	0.12790728+C4	0.26960472+05
2	0.5613635+02	0.59673229+C0	0.60323334+02	0.50379999+02
3	0.39612231+03	0.68295048+C3	0.80983936+C2	0.18826466+C3
4	0.1452988+03	0.28059772+C0	0.33119544+01	0.15046625+C5
5	0.5950000+02	0.3621886+C0	0.3190030+C2	0.35814287+C0
6	0.8115802+01	0.17332696+C2	0.69106001+02	0.37700000+02
	112.0000	87959.50	3475.690	35.19454
	279.6794	20957874.25	81409.830	34.64725
	28.2941	11.69	369845.816	0.33000
0.	0.31171089+C1	0.38564887+C4	0.22921002+C6	0.77066773+C0
0.32999999-00	0.97575654-C2	0.15732286+C4	0.37108701+C5	0.28783953-C0
0.	0.30741064-C1	0.19296566+C4	0.20996591+C8	0.56852237+C0
0.32064492+03	0.32064492+C3	0.29006003+C4	0.81431324+C0	0.45367002-C0
0.12956434+C7	0.67898849+C8	0.14146867+C3	0.29083863+C3	0.32213196+C4
1	0.74819807+C2	0.22485676+C1	0.12797798+C0	0.26937032+C3
2	0.56045089+C2	0.66509653+C2	0.60325737+C2	0.66791286+C2
3	0.3962260+03	0.98375727+C3	0.80849256+C2	0.18852107+C3
4	0.15221659+C0	0.22042918+C0	0.35885837+C1	0.14535599+C5
5	0.5950000+C2	0.36882639+C2	0.31182254+C2	0.29961572-C0
6	0.80683839+01	0.17197161+C2	0.67200001+C2	0.37400001+C2
	114.0000	91961.25	3639.024	34.41025
	279.6972	21001877.25	81497.617	33.98725
	28.2929	12.62	370153.754	0.33000
0.	0.3159893+C1	0.40119506+C4	0.23707752+C6	0.77675166+C0
0.32999999-00	0.97573517-C3	0.16316397+C4	0.40313350+C2	0.29011116-C0
0.	0.30621981-C1	0.19813377+C4	0.21000502+C8	0.55900641+C0
0.32482450+03	0.32482450+C3	0.29362969+C4	0.83089715+C3	0.46923018-C0
0.12289459+C7	0.70421984+C8	0.14175470+C3	0.29095122+C3	0.32619523+C4
1	0.76376963+C2	0.22518477+C1	0.12805200+C4	0.26939193+C3
2	0.5558607+C2	0.61356787+C2	0.60336662+C2	0.67713059+C2
3	0.39592117+C3	0.88455893+C3	0.80709422+C2	0.18868151+C3
4	0.15885088+C3	0.30886222+C1	0.37680151+C1	0.14024800+C5
5	0.5950000+C2	0.31127454+C2	0.31377250+C2	0.24975615-C0
6	0.80162584+C1	0.17648822+C2	0.65330001+C2	0.37100000+C2
	116.0000	96076.25	3824.434	33.66779
	279.7160	21005994.00	81572.605	33.32725
	28.2916	13.63	370438.785	0.33000
0.	0.32846372+C1	0.41728967+C4	0.24526148+C6	0.78273252+C0
0.32999999-00	0.97522586-C3	0.16916171+C4	0.43636274+C5	0.29234430-C0
0.	0.35321614-C1	0.20346646+C4	0.21004517+C8	0.56942027+C0
0.32849529+C3	0.32849529+C3	0.29718165+C4	0.85583612+C0	0.49267530-C0
0.11827344+C7	0.72827568+C8	0.14211398+C3	0.29105131+C3	0.33011676+C4
1	0.77938876+C2	0.22549310+C1	0.12812685+C4	0.26934414+C3
2	0.55871397+C2	0.62211000+C2	0.60349817+C2	0.68629831+C2
3	0.39581957+C3	0.88544911+C3	0.80569245+C2	0.18877489+C3
4	0.16157083+C3	0.32321618+C1	0.38741213+C1	0.13514176+C5
5	0.5950000+C2	0.31357458+C2	0.31555252+C2	0.20756638-C0
6	0.79557316+C1	0.16879551+C2	0.63400000+C2	0.36800000+C2
	116.0000	96076.25	3824.434	33.66779
	279.7160	21005994.00	81572.605	33.32725
	28.2916	13.63	370438.785	0.33000

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0. 0.29989879-C6 0.19711607+04 C.21335714+08 C.29586541-00 -0.17919493-C2 0.95522627+00 C.72790562+02
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0.35028615+03 -0.35028615+03 C.44332670+04 0.34847228+02 0.34476399+02 0.48175003+04 0.30248730+03 0.68739043+08
0.33194447+01 0.96515540+08 C.15272148+C3 C.75598364+02
1 -0.57370322+01 C.69109644+C1 C. 0.69794209+02 C.14509264+C3 0.20823654+C3 -0.87399998+C1 0.12010283+00
2 0. 0. C.41734198+02 C.29092701+02 C.50379999+02 0.68445747+02 0.11938833+C4 0.11236688+04
3 0. 0. C.88224629+01 0.60971744+02 0. 0. 0.88224629+C1 0.60971744+02
4 0.29639999+C3 -0.73239998+C1 C.94419996+C1 0.72199999+03 0.19719999+C4 0. 0.41789126+00 0.21911237+01
5 0.53420336+02 0.31819614+02 C.31819614+02 0.93013836+07 C.20850981+C1 -0.61961072+03 0.37488564+00 0.88172007+00
6 -0.50189927-C1 -0.68864057+00 0. 0.17600003+C2 C. 0.38000145+C1 0.12111603+02 0.68445747+02
PFM = C.41385508+02

244.1306 474761.75 11374.528 14.30502 12705.164 12.77990 -0.01 96.567 0.00
282.8090 21384954.75 303.622 17.20944 44458.972 0.00724 0.01 6.783 0.00
28.C221 178.20 3574.914 C. 48.167 5.66091 0.00 0.257 0.06
0. 0.87238409-C1 C.11701915+C5 C.13642173+C7 C.89320754+00 -0.35393526+00 -0.27732018+00 0.26720886+02
0. 0.10209181-07 C.45409381+04 C.48123270+C6 C.33858534-C0 C.93526716+00 -0.10311664+00 0.70209290+02
0. 0.29927099-C6 C.19662771+04 C.21339711+08 C.29586541-00 -0.17919493-C2 0.95522627+00 0.72790562+02
0.35028615+03 -0.35028615+03 C.44332670+04 C.34850708+C2 C.34476399+02 0.48184655+04 0.30243307+C3 0.68739043+08
0.32988811+01 C.96515540+08 C.15272148+C3 C.80522726+C2
1 -0.55811462+01 C.78649055+C1 C. 0.47316979+02 C.14416810+C3 0.20015146+C3 -0.87399998+C1 C.87238409-01
2 0. 0. C. 0.41694086+02 C.28974175+02 C.50379999+C2 0.68446090+02 0.11939204+C4 0.11235323+C4
3 0. 0. C.53375103+C1 C.41979469+C2 C. 0. 0.53375103+C1 0.41979469+C2
4 0.29639999+C3 -0.73239998+C1 0.94419996+C1 C.72199999+03 0.19719999+C4 0. 0.41789126+00 0.21911237+01
5 0.53420336+02 C.31819614+02 C.31819614+02 0.92658304+C7 C.20850981+C1 -0.61961072+03 0.37488564+00 0.88172007+00
6 -0.50189927-C1 -0.68864057+00 C. 0.17600003+C2 C. 0.38000145+C1 0.12111603+02 0.68445747+02
PFM = 0.31199999+02

244.1706 474873.75 11374.301 14.30055 12704.968 12.77586 -0.01 96.568 0.00
282.8104 21385067.00 303.622 17.20944 44457.884 0.00724 0.01 6.789 0.00
28.C219 178.27 640.211 C. 6.188 5.65892 0.00 0.257 0.06
0. 0.32159255-C1 C.11701936+C5 C.13644853+C7 C.89320754+00 -0.35393526+00 -0.27732018+00 0.26720886+02
0. 0.10192881-07 C.45409349+C4 C.48141434+C6 C.33858534-C0 C.93526716+00 -0.10311664+00 0.70209290+02
0. 0.29927099-C6 C.19662771+04 C.21339711+08 C.29586541-00 -0.17919493-C2 0.95522627+00 0.72790562+02
0.35028615+03 -0.35028615+03 C.44332670+04 C.34850708+C2 C.34476399+02 0.48184655+04 0.30243307+C3 0.68739043+08
0.32925811+01 C.96515540+08 C.15272148+C3 C.23106852+C3
1 -0.63629673+C1 C. 0. 0.53375103+C1 C.14395460+C3 0.20067509+C3 -0.87399998+C1 C.32159255-01
2 0. 0. C. 0.41639207+C2 C.28971928+C2 C.50379999+C2 0.68446195+02 0.11939204+C4 0.11235323+C4
3 0. 0. C.53375103+C1 C. 0. 0. 0.53375103+C1 0. 0.
4 0.29639999+C3 -0.73239998+C1 0.94419996+C1 C.72199999+03 0.19719999+C4 0. 0.41789126+00 0.21911237+01
5 0.53420336+02 C.31819614+02 C.31819614+02 0.92658304+C7 C.20850981+C1 -0.61961072+03 0.37488564+00 0.88172007+00
6 -0.50189927-C1 -0.68864057+00 C. 0.17600003+C2 C. 0.38000145+C1 0.12111603+02 0.68445747+02
PFM = 0.

245.0000 477193.25 11368.716 14.20715 12700.016 12.69147 -0.01 96.584 0.00
282.8379 21387389.00 303.622 17.20944 44453.929 0.00724 0.01 6.910 0.00
28.C191 179.74 299.825 C. 3.350 5.61776 0.00 0.258 0.06
0. 0.18984134-C1 C.11700895+C5 C.13743906+C7 C.89320754+00 -0.35393526+00 -0.27732018+00 0.26720886+02
0. 0.98587893-C8 C.45409349+C4 C.48180511+C6 C.33858534-C0 C.93526716+00 -0.10311664+00 0.70209290+02
0. 0.29927099-C6 C.19397910+C4 C.21337669+C8 C.29586541-00 -0.17919493-C2 0.95522627+00 0.72790562+02
0.35028615+03 -0.35028615+03 C.44332670+04 C.34850708+C2 C.34476399+02 0.48184655+04 0.30243307+C3 0.68739043+08
0.31649374+01 C.96515542+C8 C.15275703+C3 C.25194234+C3
1 -0.64537343+01 C. 0. 0.24996773+01 C.14070446+C3 C.20067509+C3 -0.87399998+C1 C.18984134-01
2 0. 0. C.41570378+02 C.28732963+C2 C.50379999+C2 0.68448372+02 0.11940593+C4 0.11255417+C4
3 0. 0. C.24996773+01 C. 0. 0. 0.24996773+C1 0. 0.
4 0.29639999+C3 -0.73239998+C1 0.94419996+C1 C.72199999+03 0.19719999+C4 0. 0.41789126+00 0.21911237+01
5 0.53352477+02 C.31800655+C2 C.31800655+C2 0.90355062+C7 C.20850981+C1 -0.61961072+03 0.37488564+00 0.88172007+00
6 -0.80306978-02 -0.14153276-00 C. 0.17450003+C2 C. 0.31000156+C1 0.12111603+02 0.68448372+C2
PFM = 0.

CASE 1 TRAJECTORY ID -6 NOM SECTION 3 PAGE 39
245.7306 479223.00 11363.542 14.12464 12695.398 12.61689 -0.01 96.599 0.00
282.8622 21389421.00 327.918 17.20944 44452.395 0.00738 0.01 7.016 0.00
28.C166 181.04 0. 0. 0.850 5.58232 0.00 0.260 0.06
0. 0.73766922-C2 0.11699735+C5 C.13829387+C7 C.89320754+00 -0.35393526+00 -0.27732018+00 0.26720886+02
0. 0.95799936-C8 C.45401265+C4 C.48849761+C6 C.33858534-C0 C.93526716+00 -0.10311664+00 0.70209290+02
0. 0.29259104-C6 C.19174427+C4 C.21339078+C8 C.29586541-00 -0.17919493-C2 0.95522627+00 0.72790562+02
0.35028615+03 -0.35028615+03 C.44450247+C4 C.34859469+C2 C.34488639+C2 0.48301703+C4 0.30244862+C3 0.68711120+C8
0.30584180+01 C.96515544+C8 C.15278267+C3 C.38578543+C3
1 -0.65336986+01 C. 0. 0. 0.13979135+C3 0.20067509+C3 -0.87399998+C1 C.73766922-02
2 0. 0. C.41509848+C2 C.28681015+C2 C.50379999+C2 0.68450291+02 0.11940593+C4 0.11255431+C4
3 0. 0. C. 0. 0. 0. 0. 0.
4 0.29639999+C3 -0.73239998+C1 0.94419996+C1 C.72199999+03 0.19719999+C4 0. 0.41789126+00 0.21911237+01
5 0.53302900+C2 C.31786804+C2 C.31786804+C2 0.88501489+07 C.20850981+C1 -0.61961072+03 0.37488564+00 0.88172007+00
6 -0.31283724-02 -0.54997536-C1 C. 0.17340416+C2 C. 0.25886077+01 0.12111603+02 0.68450291+02
PFM = 0.

END DECAY

245.7306 479223.00 11363.542 14.12464 12695.398 12.61689 -0.01 96.599 0.00
282.8622 21389421.00 327.918 17.20944 44452.395 0.00738 0.01 7.016 0.00
28.C166 181.04 0. 0. 0.850 5.58232 0.00 0.260 0.06
0. 0.73766922-C2 0.11699735+C5 C.13829387+C7 C.89320754+00 -0.35393526+00 -0.27732018+00 0.26720886+02
0. 0.95799936-C8 C.45401265+C4 C.48849761+C6 C.33858534-C0 C.93526716+00 -0.10311664+00 0.70209290+02
0. 0.29259104-C6 C.19174427+C4 C.21339078+C8 C.29586541-00 -0.17919493-C2 0.95522627+00 0.72790562+02
0.35028615+03 -0.35028615+03 C.44450247+C4 C.34859469+C2 C.34488639+C2 0.48301703+C4 0.30244862+C3 0.68711120+C8
0.30584180+01 C.96515544+C8 C.15278267+C3 C.38578543+C3
1 -0.65336986+01 C. 0. 0. 0.13979135+C3 0.20067509+C3 -0.87399998+C1 C.73766922-02
2 0. 0. C.41509848+C2 C.28681015+C2 C.50379999+C2 0.68450291+02 0.11940593+C4 0.11255431+C4
3 0. 0. C. 0. 0. 0. 0. 0.
4 0.29639999+C3 -0.73239998+C1 0.94419996+C1 C.72199999+03 0.19719999+C4 0. 0.41789126+00 0.21911237+01
5 0.53302900+C2 C.31786804+C2 C.31786804+C2 0.88501489+07 C.20850981+C1 -0.61961072+03 0.37488564+00 0.88172007+00
6 -0.31283724-02 -0.54997536-C1 C. 0.17340416+C2 C. 0.25886077+01 0.12111603+02 0.68450291+02

APPENDIX B

REASSEMBLY TRAJECTORY LISTING

The first four pages of the IBM trajectory listing present the various input quantities that define the trajectory, computation sequence, weights, propulsion data, etc. The trajectory listing is divided into sections that correspond to contiguous flight phases:

<u>SECTION</u>	<u>TRAJECTORY EVENT</u>	<u>STAGE</u>
1	Liftoff (2-Inch Motion, $t = 0$ sec)	Atlas
2	Booster Jettison	
3	Sustainer Jettison	
4	Main engine ignition and thrust buildup	
5	Continue Centaur main engine burn	Centaur
6	Admit Centaur Guidance perigee altitude control	
7	Main engine cutoff and space-craft separate	
	End Centaur tank retromaneuver	

A description of the trajectory parameters is presented in Appendix C.

APRIL 1965 ASSEMBLY-A CPU 1

CCC = 1. 3. 30M COMBO INITIAL CONDITIONS DATA *

DATA = 25.
 LATE = 28.307492.
 LPMG = 80.541179.
 RO = .34410000+4.30168000+4.
 BFTGH = 307510.
 CUL = .10000000+1. .10000000+1. .1476539+9. .32174000+2. .20925738+8.
 R1 = .20895588+8. .37460000-2. .90000000-5. .41780742-2. .10000000+1.
 V131 = .10000000+1.10000000+1.
 PS151 = .10000000+1.10000000+1.
 QTL = .10000000-3. .80000000+8. .14747657+2. .10080000+3. .12500000+3.
 RSPL =10000000+1.
 C3 = .57500000-5.
 GTPAD = 0.160547.
 PRGT = 0.160547.
 PSURD = 14.768405.
 STORF = 1.
 TIME = 0.
 COORD = 0.
 MXTM = -8.9254.
 MS =
 C.51845817-3. C.24189771-3. 0.55999975.
 -0.31071534-3. 0.99999984. -0.24170379-3.
 -0.99999974. -0.31016821-3. 0.51858860-3.
 DRFTPL = +1.
 ID711 = 0.32613834.
 CKURN = 2.
 SOKTIM = 1.281.
 PLTMO = 145. 230. 800. 10000.
 PLTMO = 2. 5. 10. 100.
 *

CCC = 1. 1. 30M COMBO SECTION 1 DATA *
 FCNDE = 02. 04. 08. 17. 28. 62. 12. 14. 15. 16. 17. 18. 71.
 FCNDE = 02. 04. 08. 17. 28. 62. 12. 14. 15. 16. 17. 18. 71. 80.
 CTIME = .50000000+0.12000000+2.40000000+1.
 DTIME = 1.
 STGF = 1.
 STG1 = 141.83614.
 AR11 =72980000+4. .80800000+0. .78500000+2.
 JETM = 7225.
 OPT1 = 2. 9. 12.
 OPT6 =78500000+2. .10000000+1. .10000000+1. .10000000+1.
 FCNCP = .10000000+1. .10000000+1.
 PMWR = .10000000+1. .86603000+0.30000000+1. .31000000+1.
 CANT = .7547.
 CKML = 3.056.
 DKRP = 0.11 .0.25 .0.35 .0.70 .1.70 .
 DKTM = 0.70 .0.15 .0.092 .0.043 .0.00 .
 DKWD = 0.912 .0.800 .0.0267 .0.00 .0.00 .
 PRNT = -0.
 WNDP = 1.498.
 YLTX = 1.013806.
 ROLX = 0.58650847.
 ADJT = 1. C. 0.61909731, 0.58572729.
 PRNT = -2.
 PRNT = +0.
 *

CCC = 1. 2. 30M COMBO SECTION 2 DATA *
 FCNDE = 02. 04. 08. 17. 28. 62. 12. 14. 15. 16. 17. 18. 71.
 CTIME = 1.
 STGF = 1.
 STG1 = 233.
 AR11 =80800000+0. .78500000+2.
 JETM = -36360.
 OPT1 = 2. 9. 12.
 OPT6 =78500000+2. .40000000+1. .40000000+1. .20000000+1.
 FCNCP = .40000000+1. .20000000+1.
 PMWR = .20000000+1. .64279000+0.20000000+1. .15000000+1.
 CANT = .7547.
 CKML = 3.289.
 DKRP = 0.85. 1.281. 1.45. 1.775. 3.289.
 DKTM = 0.54. 0.736. 0.275. 0.0384. 0.0.
 DKWD = 0.582. 0.754. 0.488. 0.240. 0.0.
 PRNT = -0.
 GUID = 1.
 TURN = 0.0.
 FORCE = 4.9.
 GUID = 2.
 FORCE = 4.613.
 YLTX = 1.
 PRNT = -2.
 PRNT = +0.
 *

CCC = 1. 3. 30M COMBO SECTION 3 DATA *
 FCNDE = 2. 4. 09. 37. 22. 15. 16. 18. 71.
 RTAD = 8.72. WNDT = 4.48.
 CTIME = .50000000+0.90000000+1.
 DTIME = 1.
 STG1 = 6.481.
 OPT1 = 2. 9. 12.
 ADJT = 1. C. -2.1220956. -1.4144974.
 PRNT = +0.
 *

CCC = 1.4.*
 FCNDE = 2. 4. 09. 37. 22. 15. 16. 18. 71.
 CTIME = 1.
 GUID = 2.0.
 FORCE = 4.
 TURN = 0.0.
 OPT1 = 2. 9. 12.
 FCNTM = 4.
 PRNT = +0.
 DTG = -1.
 DT1 = .1. 1.
 DM1 = 2. 1000.
 RTB = 0.58161955.
 KNOTB = 0.58694982.
 STGF = 1. 233.17.
 RTAD = 8.72.
 WNDAD = 0.103.
 *

CCC = 1. 5. 30M COMBO SECTION 5 DATA *
 FCNDE = 2. 4. 09. 37. 22. 15. 16. 18. 71.
 CTIME = 1.
 GUID = 2.0.
 TURN = 0.0.
 OPT1 = 2. 9. 12.
 FCNTM = 2.
 PRNT = +0.
 *

KTB = 0.58161955.
 KNOTB = 0.58694982.
 STGF = 1.
 STG1 = 496.17.
 RTAD = 8.72.
 WNDAD = 0.103.
 ADJT = 1. 0. -0.66557827-1.
 *

CCC = 1. 6. 30M COMBO SECTION 6 DATA *
 FCNDE = 2. 4. 09. 37. 22. 15. 16. 18. 71.
 CTIME = 1.
 GUID = 2.0.
 TURN = 0.0.
 FCNTM = 1.
 OPT1 = 2. 9. 12. 13.
 RTB = 0.58161955.
 KNOTB = 0.58694982.
 STGF = 1. 479.08.
 WNDAD = 0.103.
 RTAD = 8.72.
 DKEN = 3.
 CKML = 68.72.
 DKRP = 0.09. 0.1. 68.62. 68.72.
 DKTM = 1.46613. 290524-3. -29524-3. 0.101.
 DKWD = 7.235. -0.014679. -0.014679. 0.0014679.
 JETM = 2064.
 PRNT = +0.
 *

CCC = 1. 7. 30M COMBO SECTION 7 DATA *
 FCNDE = 2. 4. 09. 37. 22. 15. 16. 18. 71.
 DM1 = 5. 97.2. 1000.
 DM11 = 0.0. 1.9522777. 0.
 TURN = 12.
 FCNTM = 2.
 CTIME = 1.
 OPT1 = 2. 9. 12. 13.
 FCNTM = 9.
 FCNTM = 9.
 RTB = 1.
 KNOTB = 1.
 STGF = 1. 1853.8.
 PRNT = 0.
 *

CCC = 2.38.*
 TIME4 =
 0.0. 1.0. 2.0. 3.0. 4.0. 5.0. 6.0. 7.0. 8.0. 9.0. 1.0. 1.1. 1.2.
 1.3.
 7.4. F.4. 30.4. 80.4. 90.4.
 TMST4 =
 8.8. 706. 1867. 2321. 2321. 2321. 2422. 2623. 2977.
 3522. 5751. 8324. 16850. 33902. 31198. 28151. 20757.
 29866. 30165. 30119. 30320. 30430. 30220. 30170. 30280.
 WNDT4 =
 4.48. 8.27. 5.48. 9.08. 8.68. 10.09. 12.11. 12.71. 15.14. 28.66.
 56.71. 65.38. 64.58. 74.26. 75.68. 71.03. 73.05. 72.65. 71.84.
 70.63. 70.13. 70.13. 69.64. 69.60. 69.84.
 TIME2 =
 0.0. 5. 41. 54. 56. 65. 70. 79. 83. 89. 92. 103.
 105. 115. 12. 130. 138. 145. 150. 156. 158. 166.
 TMST2 =
 30290. 30390. 30900.
 30000. 30240. 25800. 30270. 29920. 30320. 29980. 29890.
 29890. 30180. 29770. 30180. 29560. 30090. 29910. 30140.
 29910. 30140. 25860.
 WNDT2 =
 65.65. 71.70. 71.90.
 68.00. 69.78. 68.55. 69.90. 68.80. 70.08. 68.95. 68.66. 68.71.
 68.60. 68.35. 68.65. 67.77. 69.30. 68.79. 69.51. 68.87. 69.60.
 69.66.
 TIME1 =
 0. 14. 21. 23. 27. 29. 45. 49. 58. 63. 67. 82. 85.
 91. 93. 99. 108. 113. 119. 125. 140. 151. 163. 168.
 173. 184.
 TMST1 = 25850.
 25850. 25850. 25850. 25850. 25850. 25850. 25850. 25850.
 30200. 25850. 25850. 30050. 29760. 29920. 29580. 30020.
 25850. 25730. 29460. 30000. 29660. 29960. 29800. 30500.
 30610.
 WNDT1 = 68.66.
 68.65. 68.06. 68.44. 68.30. 68.80. 68.37. 69.90. 68.05. 69.70.
 69.02. 68.75. 69.25. 68.35. 68.82. 67.85. 69.16. 68.45. 68.30.
 67.50. 65.10. 64.10. 68.99. 68.48. 70.80. 71.10.
 71.1.
 TIME5 =
 0. 0.1. 0.1001. 125. 125.0001. 212.2. 212.2001. 252.2.
 252.2001. 552.2. 802.2. 1052.2. 1108.8.
 TMST5 =
 -1370. -1370. 0.0. 0.0. 51.6. 51.6. 42.0. 42.0. 22.5. 16.6.
 11.0. 7.0. 7.0.
 WNDT5 =
 0. 0. 0. 0. 2.76. 2.76. 1.71. 1.71. 0.54. 0.40. 0.27.
 0.15. 0.15.
 *

CCC = 1. 1. 30M DEPRD INITIAL CONDITIONS DATA *
 PU = .20000000+1. .10000000+1.
 PL=4.
 PLCS2=3.13 .RTB=2.28 .VAPIN=-5.75 .VAPAX=17.05 .
 VAPAX = 14.10.
 VAPIN = -5.40.
 WMIN=1835.0 .WFIN=883.0 .CNC=2340.0 .DMF=943.0 .
 PGAD = 25.5.
 PGYVM = 20.0.
 PGAD = 55.5.
 WDSOL = 8.125.
 TWPL = -1.10.
 WDM = .17250000+6. .75149300+5. .16600000+3. .53000000+2.
 WDM = 54647.
 WDM = 17228.
 WDM = 76103.
 WDM = 169.
 WDM = 86.
 LOXCO = -0.08.
 *

CCC = 3. 2. 30M DEPRD SECTION ONE DATA *
 OUTPR=1.0 .CSTAF=1.0 .
 FDEN=50. .PLFA=12.4 .PLCB=18.6 .PLFS=11.8 .PLOS=15.1 .
 FDEN = 50.38.
 GASPP=4.
 *

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[illegible]

GDC-BTD66-012

CASE 1	TRAJECTORY ID -6 ACW	SECTION 1	PAGE 3
1 C.15957580+02	C.21939080+01	C.12097170+04	C.27490005+03
2 C.16087843+02	C.15447070+02	C.12068995+02	C.59386680+02
3 C.16067423+03	C.08904330+03	C.08336570+02	C.19163020+03
4 C.12799966+02	C.13290000+01	C.13290000+01	C.0
5 C.15755704+02	C.26155705+02	C.26155705+02	C.14544214+02
6 C.17700061+01	C.19248333+02	C.15659000+03	C.51499999+02
12.0000	672.75	119.201	85.19849
279.4588	27910574.50	60073.410	90.06602
28.3075	9.38	326031.355	-0.00046
1 C.15533011+01	C.13554677+01	C.12148321+04	C.50271905+03
2 C.15462713+02	C.10335327+02	C.506863611+03	C.41349121+05
3 C.15233120+02	C.01959425+02	C.11657581+03	C.20914730+08
4 C.15466114+01	C.13466114+01	C.30647471+03	C.43226060+01
5 C.15849226+04	C.52779023+04	C.10128538+03	C.24470157+03
1 C.15468094+02	C.21947140+01	C.12099087+04	C.27496002+03
2 C.15493937+02	C.54097277+02	C.72739087+02	C.50623973+02
3 C.15496375+03	C.09095536+03	C.03357312+02	C.19160271+03
4 C.15799996+02	C.13390000+01	C.13290000+01	C.0
5 C.15842108+02	C.26341766+02	C.26220592+03	C.14438914+02
6 C.17284332+01	C.19275435+02	C.15459999+03	C.51199999+02
14.0000	933.50	142.566	89.06296
279.4588	27910355.25	60378.495	90.05639
28.3075	13.44	326492.355	-0.00546
1 C.15533011+01	C.13728630+01	C.12143683+04	C.52701111+05
2 C.15462713+02	C.14620196+02	C.50686567+03	C.42211829+05
3 C.15233120+02	C.02734454+02	C.14033160+03	C.20910730+08
4 C.15466114+01	C.14518242+01	C.45708200+03	C.51252149+01
5 C.15849226+04	C.13795310+05	C.10401002+03	C.24525228+03
1 C.15468094+02	C.22090936+01	C.13001152+04	C.27496248+03
2 C.15493937+02	C.55139266+02	C.72716955+02	C.50687670+02
3 C.15496375+03	C.09095787+03	C.03174861+02	C.19317566+03
4 C.15799996+02	C.12034958+01	C.12034958+01	C.0
5 C.15842108+02	C.26548791+02	C.26249477+02	C.14311207+02
6 C.17271503+01	C.19210067+02	C.15260999+03	C.50600000+02
16.0000	1242.75	167.144	89.06421
279.4588	27911144.50	60698.277	89.56919
28.3075	18.55	32727.824	-0.48118
1 C.15533011+01	C.13728630+01	C.12143683+04	C.55129030+05
2 C.15462713+02	C.12647562+02	C.50687423+03	C.43074473+05
3 C.15233120+02	C.02734454+02	C.14033160+03	C.20910730+08
4 C.15466114+01	C.14518242+01	C.45708200+03	C.51252149+01
5 C.15849226+04	C.13795310+05	C.10401002+03	C.24525228+03
1 C.15468094+02	C.22090936+01	C.13001152+04	C.27496248+03
2 C.15493937+02	C.55139266+02	C.72716955+02	C.50687670+02
3 C.15496375+03	C.09095787+03	C.03174861+02	C.19317566+03
4 C.15799996+02	C.12034958+01	C.12034958+01	C.0
5 C.15842108+02	C.26548791+02	C.26249477+02	C.14311207+02
6 C.17271503+01	C.19210067+02	C.15260999+03	C.50600000+02
18.0000	1602.25	193.000	89.36426
279.4588	27911504.00	61003.032	89.60771
28.3075	23.39	327641.535	-0.48118
1 C.15533011+01	C.13728630+01	C.12143683+04	C.55129030+05
2 C.15462713+02	C.12647562+02	C.50687423+03	C.43074473+05
3 C.15233120+02	C.02734454+02	C.14033160+03	C.20910730+08
4 C.15466114+01	C.14518242+01	C.45708200+03	C.51252149+01
5 C.15849226+04	C.13795310+05	C.10401002+03	C.24525228+03
1 C.15468094+02	C.22090936+01	C.13001152+04	C.27496248+03
2 C.15493937+02	C.55139266+02	C.72716955+02	C.50687670+02
3 C.15496375+03	C.09095787+03	C.03174861+02	C.19317566+03
4 C.15799996+02	C.12034958+01	C.12034958+01	C.0
5 C.15842108+02	C.26548791+02	C.26249477+02	C.14311207+02
6 C.17271503+01	C.19210067+02	C.15260999+03	C.50600000+02
20.0000	2014.50	229.143	89.76669
279.4588	27911916.25	61349.964	87.64551
28.3075	26.28	328033.168	-0.48118
1 C.15533011+01	C.13728630+01	C.12143683+04	C.55129030+05
2 C.15462713+02	C.12647562+02	C.50687423+03	C.43074473+05
3 C.15233120+02	C.02734454+02	C.14033160+03	C.20910730+08
4 C.15466114+01	C.14518242+01	C.45708200+03	C.51252149+01
5 C.15849226+04	C.13795310+05	C.10401002+03	C.24525228+03
1 C.15468094+02	C.22090936+01	C.13001152+04	C.27496248+03
2 C.15493937+02	C.55139266+02	C.72716955+02	C.50687670+02
3 C.15496375+03	C.09095787+03	C.03174861+02	C.19317566+03
4 C.15799996+02	C.12034958+01	C.12034958+01	C.0
5 C.15842108+02	C.26548791+02	C.26249477+02	C.14311207+02
6 C.17271503+01	C.19210067+02	C.15260999+03	C.50600000+02
22.0000	2482.25	248.554	88.60329
279.4588	27912344.00	61734.545	86.68320
28.3075	26.40	329331.105	-0.48118
1 C.15533011+01	C.13728630+01	C.12143683+04	C.55129030+05
2 C.15462713+02	C.12647562+02	C.50687423+03	C.43074473+05
3 C.15233120+02	C.02734454+02	C.14033160+03	C.20910730+08
4 C.15466114+01	C.14518242+01	C.45708200+03	C.51252149+01
5 C.15849226+04	C.13795310+05	C.10401002+03	C.24525228+03
1 C.15468094+02	C.22090936+01	C.13001152+04	C.27496248+03
2 C.15493937+02	C.55139266+02	C.72716955+02	C.50687670+02
3 C.15496375+03	C.09095787+03	C.03174861+02	C.19317566+03
4 C.15799996+02	C.12034958+01	C.12034958+01	C.0
5 C.15842108+02	C.26548791+02	C.26249477+02	C.14311207+02
6 C.17271503+01	C.19210067+02	C.15260999+03	C.50600000+02
24.0000	3088.00	278.380	87.57476
279.4588	27912900.75	62164.760	85.72088
28.3075	29.00	330412.960	-0.48118
1 C.15533011+01	C.13728630+01	C.12143683+04	C.55129030+05
2 C.15462713+02	C.12647562+02	C.50687423+03	C.43074473+05
3 C.15233120+02	C.02734454+02	C.14033160+03	C.20910730+08
4 C.15466114+01	C.14518242+01	C.45708200+03	C.51252149+01
5 C.15849226+04	C.13795310+05	C.10401002+03	C.24525228+03
1 C.15468094+02	C.22090936+01	C.13001152+04	C.27496248+03
2 C.15493937+02	C.55139266+02	C.72716955+02	C.50687670+02
3 C.15496375+03	C.09095787+03	C.03174861+02	C.19317566+03
4 C.15799996+02	C.12034958+01	C.12034958+01	C.0
5 C.15842108+02	C.26548791+02	C.26249477+02	C.14311207+02
6 C.17271503+01	C.19210067+02	C.15260999+03	C.50600000+02
26.0000	3593.75	309.748	86.43188
279.4588	27913405.50	62626.366	84.75855
28.3075	50.43	331384.215	-0.48118
1 C.15533011+01	C.13728630+01	C.12143683+04	C.55129030+05
2 C.15462713+02	C.12647562+02	C.50687423+03	C.43074473+05
3 C.15233120+02	C.02734454+02	C.14033160+03	C.20910730+08
4 C.15466114+01	C.14518242+01	C.45708200+03	C.51252149+01
5 C.15849226+04	C.13795310+05	C.10401002+03	C.24525228+03
1 C.15468094+02	C.22090936+01	C.13001152+04	C.27496248+03
2 C.15493937+02	C.55139266+02	C.72716955+02	C.50687670+02
3 C.15496375+03	C.09095787+03	C.03174861+02	C.19317566+03
4 C.15799996+02	C.12034958+01	C.12034958+01	C.0
5 C.15842108+02	C.26548791+02	C.26249477+02	C.14311207+02
6 C.17271503+01	C.19210067+02	C.15260999+03	C.50600000+02
28.0000	3593.75	309.748	86.43188
279.4588	27913405.50	62626.366	84.75855
28.3075	50.43	331384.215	-0.48118
1 C.15533011+01	C.13728630+01	C.12143683+04	C.55129030+05
2 C.15462713+02	C.12647562+02	C.50687423+03	C.43074473+05
3 C.15233120+02	C.02734454+02	C.14033160+03	C.20910730+08
4 C.15466114+01	C.14518242+01	C.45708200+03	C.51252149+01
5 C.15849226+04	C.13795310+05	C.10401002+03	C.24525228+03
1 C.15468094+02	C.22090936+01	C.13001152+04	C.27496248+03
2 C.15493937+02	C.55139266+02	C.72716955+02	C.50687670+02
3 C.15496375+03	C.09095787+03	C.03174861+02	C.19317566+03
4 C.15799996+02	C.12034958+01	C.12034958+01	C.0
5 C.15842108+02	C.26548791+02	C.26249477+02	C.14311207+02
6 C.17271503+01	C.19210067+02	C.15260999+03	C.50600000+02

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PAGE 1				TRAJECTORY ID -6 MCP				SECTION 1				PAGE 10			
0.	0.21707944+01	-0.23797044+02	0.37563770+04	0.07502575+00	0.62760139+00	0.35956414+04	0.27140201+03	0.56276800+08							
1	0.10035775+03	0.23741635+01	0.13064132+00	0.26957956+03	0.12148324+05	0.29205999+05	-0.53599990+01	0.47953349+01							
2	0.05490958+02	0.73237561+02	0.40361796+02	0.00902166+02	0.50379394+05	0.68219997+02	0.11318903+04	0.06795284+03							
3	0.40776476+03	0.50564896+03	0.76281877+02	0.19337937+03	0.	0.	0.47697792+03	0.10900230+04							
4	0.43496569+03	-0.79390996+01	0.79390996+01	0.	0.	0.	0.	0.22030206+04							
5	0.06117753+01	0.31627796+02	0.33450311+02	0.14161319+01	0.22557967+01	-0.25454771+02	0.17880154+01	0.42179491+01							
6	0.06117753+01	0.31313158+02	0.40600001+02	0.33209000+02	0.56490005+01	0.7660001+02	0.	0.68137697+02							
124.0000	167493.00	6979.234	26.03345	8146.884	22.54690	3525.14	95.326	45.52							
280.0032	21077703.00	83603.413	26.03918	92988.270	4.96785	16.07	0.548	1.63							
28.2567	33.67	374413.961	0.20744	1575.680	6.31183	-20.30	-0.124	35623.08							
0.	0.45628527+01	0.70711690+04	0.39379880+04	0.86400284+00	-0.34392997+00	-0.61146509+00	0.32426196+02								
0.00744247+00	0.15458213+01	0.27374518+04	0.0088542+06	0.3079191+00	0.93002750+00	-0.15300635+00	0.72068121+02								
-0.15293128+00	0.16207973+01	0.20763173+04	0.21073647+00	0.43398956+00	0.24521077+02	0.69849000+00	0.63960817+02								
0.29550926+01	0.23505892+03	0.37532470+04	0.0976474+00	0.66494304+00	0.36219259+04	0.27167974+03	0.57919255+00								
0.31748161+04	0.59255058+08	0.14623270+03	0.28994253+03												
0.10275285+03	0.23001710+01	0.13076732+04	0.26959630+03	0.11154556+05	0.27005654+05	-0.53599990+01	0.49628522+01								
0.43056690+02	0.76427085+02	0.65456637+02	0.82129210+02	0.50379499+02	0.68219997+02	0.11347804+04	0.07826635+03								
0.43056690+02	0.90719381+03	0.76210596+02	0.19338587+03	0.	0.	0.47677994+03	0.11004899+04								
0.43056690+02	-0.79390996+01	0.79390996+01	0.	0.	0.	0.	0.22031576+01								
0.50598867+02	0.31477688+02	0.33450311+02	0.11331214+01	0.22645324+01	-0.22621215+02	0.13688735+01	0.32288041+01								
0.66477824+01	0.12630744+02	0.38700000+02	0.32900000+02	0.42600001+01	0.75200000+02	0.	0.68137697+02								
136.0000	173767.25	7275.927	26.44722	8446.622	22.36724	3658.98	95.352	39.39							
280.1320	21043720.53	83608.291	25.62429	89877.599	5.14231	14.91	0.544	1.30							

CONF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					

(CASE)	TIME LONGITUDE GECEFF LAT	ALTITUDE R MAGNITUDE GRND RANGE	TRAJECTORY ID -6 NOM				VELOCITY I WEIGHT WEIGHT DOT	SECTION 2		VEL R AZ ALPHA BETA	PAGE 24 DYNR PRS ATM PRS REV NUMB	
			VELOCITY RA THRST FIXD THRST CENLT	FLT PATH R PITCH ATN PITCH RATE	AXL FORCE NORM SIDE	AXL FORCE NORM SIDE						
ENGLISH UNITS												
CP XI	AC XI	VMU	RMU	L11	L12	L13	ACOL11					
OM FTA	AC ZET	VMV	RMV	L21	L22	L23	ACOL12					
CP FET	AC YET	VMW	RMW	L31	L32	L33	ACOL13					
D LCSS	G LCSS	P LCSS	ML ALF	PL BET	T LOSS	SP TMP	TCT TM					
M FLUX	H PARA	DBLCSS	ITSP									
1 NPSM	MTX	W.R	W.S	WF	WD	VALVE	ACS					
2 PTFB	PIPOB	PIPF5	PIPOS	FUDEN	FODEX	F STA	O STA					
3 W.FB	W.CO	W.FS	W.CS	W.FV	W.OV	W.F	W.O					
4 THINC	FUINC	OXINC	CAPE	CAPO	CAPRA	16PF	MIXRS					
5 PF(F)	PG(F)	PVPC	PSUBA	BPIXR	BTMNC	BFUINC	OXINC					
6 DPF	OPD	WROT	WSCI	WOME	WSMNE	EDD						
	144.9521	204011.50	8255.029	24.91222	9457.519	21.47671	-404.12	95.481		18.19		
	280.3254	21113581.50	1716.029	23.81969	72762.082	1.14798	28.96	0.251		0.40		
	28.7404	46.01	81414.564	0.	268.937	P.03C67	44.85	0.441		13513.35		
C.	0.11470917+02	0.82320215+04	0.47824134+06	0.85594261+00	-0.35229754-00	-0.37847953-00	0.31359972+02					
C.	0.31490946+02	0.13495844+04	0.13366119+06	0.32288978-00	0.93588528+00	-0.14091979-00	0.71162222+02					
C.	0.35864430+02	0.32683999+04	0.21110814+08	0.40388572-00	-0.15887876-02	0.51481872+00	0.66180372+02					
C.	0.21575424+03	-0.21973488+03	0.3552441298+04	0.111107798+01	0.75985176+00	0.37552591+04	0.309151838+03			0.61120022+08		
C.	0.14015151+04	0.55895830+08	0.14735554+03	0.30910888+03								
1	C.02055452+02	C.253706125+01	C.02680968+03	C.71220321+04	0.17515208+05	-0.53999998+01	0.11479817+01			0.89390937+03		
2	C.	C.75932551+02	C.43187737+02	C.50379999+02	C.68219997+02	0.11476858+04	0.19215463+03			0.75932551+02		
3	C.	C.75932551+02	C.43187737+02	C.	C.	0.75932551+02	0.75932551+02			0.75932551+02		
4	C.43465558+03	-0.75939994+01	0.75939994+01	C.	C.	0.75939994+01	0.75939994+01			0.75939994+01		
5	C.48957273+02	C.32062776+02	0.33450031+02	0.27961043+02	C.20709419+01	-0.71858801+03	0.43462526+00			0.10230000+01		
6	C.10677121+01	C.19677565+01	C.	0.31266179+02	C.	0.67575593+02	C.			0.68197700+02		
	145.0000	204346.25	8257.583	24.89402	9500.247	21.46175	-358.91	95.483		17.96		
	280.3279	21114356.25	1716.037	23.82032	72033.074	1.14852	30.67	0.272		0.40		
	28.7401	46.14	81414.701	0.	268.937	0.04145	44.28	0.441		13557.38		
C.	0.11495182+01	0.83266787+04	0.47913577+06	0.85593764+00	-0.35229944-00	-0.37848894-00	0.31356522+02					

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[illegible]

CASE 1	TRAJECTORY ID -6 MCP				SECTION 2				PAGE 33
	236.2890	487117.75	11480.474	14.15036	12812.695	12.65315	-0.01	96.654	0.00
	287.8743	21397331.50	C.000	16.14974	36360.000	-0.00000	0.01	5.941	0.00
	28.0017	181.77	C.	0.	C.850	5.51632	C.00	0.606	0.05
A.	-0.12047885-C	C.11811280+C5	C.13877688+C7	C.89628199+C0	-0.35815387-C0	-0.26153553-C0	C.26326425+C2		
O.	0.23960592-C7	C.45704343+C4	C.48467312+C6	C.34541068-C0	C.93364504+C0	-0.94838079-C1	C.69793131+C2		
C.	0.24570210-C6	C.19416317+C4	C.21346781+C8	C.27814862-C0	-0.53355220-C2	C.96052171+C0	C.73850259+C2		
C.22115159+C1	-0.22115159+C3	C.44421034+C4	C.23484924+C2	C.22712469+C2	C.46867398+C4	C.30862084+C3	C.68530913+C8		
C.27856591+C1	C.57008878+C8	C.15288127+C3	C.22074656-C2						
1	-C.59681788+C1	C.	C.	C.28804415+C3	C.36732312+C3	-0.53999988+C1	-C.12047885-C0		
2	C.	C.37147398+C2	C.28977320+C2	C.50379999+C2	C.68446507+C2	C.11893246+C4	C.10843053+C4		
3	C.	C.	C.	C.	C.	C.	C.		
4	C.47655559+C3	-C.79399996+C1	C.79399996+C1	C.	C.	C.	C.		
5	C.48547306+C7	C.32107320+C2	C.31814133+C2	C.81938344-C7	C.20709419+C1	-C.71858801+C3	C.43462526-C0	C.21881587+C1	
6	C.	C.	C.	C.17556650+C2	C.	C.35977020+C1	C.	C.10230000+C1	C.68440600+C2

CASE 1	TRAJECTORY ID -6 MCP				SECTION 2				PAGE 34
	TIME	ALTITUDE	VELOCITY	FLY PATH R	VELOCITY I	FLY PATH I	AXL FORCE	VEL R AZ	DYNN PRS
	LONGITUDE	R MAGNITUDE	THRST FIXED	PITCH ATT	WEIGHT	AXL TO FCTR	NORM FORCE	ALPHA	ATM PRS
	GRDCENT LAT	GRND RANGE	THRST CENCL	PITCH RATE	WEIGHT DOT	PACH NUMBER	SIDE FORCE	BETA	REV NUMB
ENGLISH UNITS									
CM XT	AC XT	VMU	RMU	L11	L12	L13		ACOL11	
CM ETA	AC ETA	VMV	RMV	L21	L22	L23		ACOL12	
CM ZET	AC ZET	VMW	RMW	L31	L32	L33		ACOL13	
C LOSS	G LOSS	M LOSS	ML ALF	ML BET	T LOSS	SP IMP		TOT IM	
M FLUX	M PARA	DBLCSS	ITSP						
	236.2890	487117.75	11480.474	14.15036	12812.695	12.65315	0.	96.654	0.00
	287.8743	21397331.50	C.	16.14974	36360.000	0.00024	0.	5.941	0.00
	28.0017	181.77	8.720	C.	4.480	C.	0.	0.606	0.05
A.	0.23962397-C3	C.11811280+C5	C.13877688+C7	C.89628199+C0	-0.35815387-C0	-0.26153553-C0	C.26326425+C2		
C.	C.	C.45704343+C4	C.48467312+C6	C.34541068-C0	C.93364504+C0	-0.94838079-C1	C.69793131+C2		
C.	C.	C.19416317+C4	C.21346781+C8	C.27814862-C0	-0.53355220-C2	C.96052171+C0	C.73850259+C2		
C.22115159+C1	-0.22115159+C3	C.44421034+C4	C.23484924+C2	C.22712469+C2	C.46867398+C4	C.30862084+C3	C.68530913+C8		
C.34441420+C2	C.57008878+C8	C.15288127+C3	C.19464285+C1						
	237.0007	489104.50	11475.170	14.07118	12807.926	12.58150	0.	96.668	0.00
	287.8743	21397331.50	C.	16.14974	36356.814	0.00024	0.	6.044	0.00
	27.5992	183.05	8.720	C.	4.480	C.	0.	0.607	0.05
A.	0.23964495-C3	C.11811280+C5	C.13877688+C7	C.89628199+C0	-0.35815387-C0	-0.26153553-C0	C.26326425+C2		
C.	C.	C.45704343+C4	C.48467312+C6	C.34541068-C0	C.93364504+C0	-0.94838079-C1	C.69793131+C2		
C.	C.	C.19416317+C4	C.21346781+C8	C.27814862-C0	-0.53355220-C2	C.96052171+C0	C.73850259+C2		
C.22115159+C1	-0.22115159+C3	C.44421034+C4	C.23484924+C2	C.22712469+C2	C.46867398+C4	C.30862084+C3	C.68530913+C8		
C.34441420+C2	C.57008878+C8	C.15288127+C3	C.19464285+C1						
	240.0000	497358.25	11453.124	13.73636	12788.108	12.27864	C.	96.729	0.00
	287.8743	21407585.25	C.	16.14974	36343.373	0.00024	0.	6.479	0.00
	27.5992	188.41	8.720	C.	4.480	C.	0.	0.613	0.05
A.	0.23963365-C3	C.11803857+C5	C.14315967+C7	C.89628199+C0	-0.35815387-C0	-0.26153553-C0	C.26326425+C2		
C.	C.	C.45704343+C4	C.48467312+C6	C.34541068-C0	C.93364504+C0	-0.94838079-C1	C.69793131+C2		
C.	C.	C.19416317+C4	C.21346781+C8	C.27814862-C0	-0.53355220-C2	C.96052171+C0	C.73850259+C2		
C.22115159+C1	-0.22115159+C3	C.44421034+C4	C.23484924+C2	C.22712469+C2	C.46867398+C4	C.30862084+C3	C.68530913+C8		
C.34441420+C2	C.57008878+C8	C.15288127+C3	C.19464285+C1						
	242.7700	504791.75	11433.247	13.42612	12770.247	11.99824	C.	96.785	0.00
	287.8743	21415028.50	C.	16.14974	36330.962	0.00024	0.	6.882	0.00
	27.5992	193.37	8.720	C.	4.480	C.	0.	0.618	0.05
A.	0.24001566-C3	C.11798172+C5	C.14642756+C7	C.89628199+C0	-0.35815387-C0	-0.26153553-C0	C.26326425+C2		
C.	C.	C.45704343+C4	C.48467312+C6	C.34541068-C0	C.93364504+C0	-0.94838079-C1	C.69793131+C2		
C.	C.	C.19416317+C4	C.21346781+C8	C.27814862-C0	-0.53355220-C2	C.96052171+C0	C.73850259+C2		
C.22115159+C1	-0.22115159+C3	C.44421034+C4	C.23484924+C2	C.22712469+C2	C.46867398+C4	C.30862084+C3	C.68530913+C8		
C.34441420+C2	C.57008878+C8	C.15288127+C3	C.19464285+C1						
	242.7700	504791.75	11433.247	13.42612	12770.247	11.99824	C.	96.785	0.00
	287.8743	21415028.50	C.	16.14974	36330.962	0.00024	0.	6.882	0.00
	27.5992	193.37	8.720	C.	4.480	C.	0.	0.618	0.05
A.	0.24001566-C3	C.11798172+C5	C.14642756+C7	C.89628199+C0	-0.35815387-C0	-0.26153553-C0	C.26326425+C2		
C.	C.	C.45704343+C4	C.48467312+C6	C.34541068-C0	C.93364504+C0	-0.94838079-C1	C.69793131+C2		
C.	C.	C.19416317+C4	C.21346781+C8	C.27814862-C0	-0.53355220-C2	C.96052171+C0	C.73850259+C2		
C.22115159+C1	-0.22115159+C3	C.44421034+C4	C.23484924+C2	C.22712469+C2	C.46867398+C4	C.30862084+C3	C.68530913+C8		
C.34441420+C2	C.57008878+C8	C.15288127+C3	C.19464285+C1						

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[illegible]

CASE 1	TRAJECTORY ID -6 ADM				SECTION 4				PAGE 37
	330.0000	683570.00	13435.600	6.47425	14809.316	5.87148	0.	98.461	0.
	284.2611	21594587.00	0.	8.77577	30372.530	0.97779	0.	9.612	0.
	27.6033	363.27	29497.930	0.08400	68.856	0.	0.	0.888	0.
-C.14993298-03	0.97778914+00	0.13802714+05	0.25773941+07	0.92052131+00	-0.36290236-00	-0.14469545-00	0.22997396+02		
C.84007349-01	0.	0.53538851+04	0.94545828+06	0.35966394-00	0.93179721+00	-0.48884979-01	0.68920439+02		
C.42977105-01	0.	-0.36585817+03	0.21419369+08	0.15256782-00	-0.70422362-02	0.58826558+00	0.81224232+02		
C.22115159+03	-0.22115159+03	0.49055439+04	0.55886713+02	0.54940604+02	0.51829821+04	0.42914397+03	0.71089240+08		
0.	0.57010513+08	0.15489225+03	0.43067639+03						
	333.1700	688698.50	13523.757	6.27827	14898.237	5.49703	0.	98.526	0.
	286.3868	21599332.50	0.	8.50742	30153.818	0.98602	0.	9.664	0.
	27.5867	370.04	29732.160	0.18388	69.032	0.	0.867	0.	0.
-C.46912425-05	0.58601641+00	0.13883459+05	0.26212765+07	0.92125916+00	-0.36272482-00	-0.14038016-00	0.22889138+02		
C.18388209-00	0.	0.53856065+04	0.96248030+06	0.35970505-00	0.93186654+00	-0.47201902-01	0.68917670+02		
0.20777014-01	0.	-0.44572362+03	0.21418774+08	0.14793739-00	-0.70109852-02	0.58896953+00	0.81492583+02		
C.22115159+03	-0.22115159+03	0.49153366+04	0.57532395+02	0.56583121+02	0.51940205+04	0.42915993+03	0.71183435+08		
0.	0.57010513+08	0.15493238+03	0.43070377+03						

CASE 1	TRAJECTORY ID -6 ADM				SECTION 5				PAGE 38
	TIME	ALTITUDE	VELOCITY RA	FLT PATH R	VELOCITY I	FLT PATH I	AXL FORCE	VEL R AZ	DYNN PRS
	LONGITUDE	R MAGNITUDE	THRST FIXED	PITCH ATT	WEIGHT	AXL LD FCTR	NORM FORCE	ALPHA	ATM PRS
	GEOCENT LAT	GRND RANGE	THRST CNTRL	PITCH RATE	WEIGHT DOT	PACH NUMBER	SIDE FORCE	BETA	REV NUMB
ENGLISH UNITS									
CP XI	AC XI	VMU	RMU		L11				ACOL11
CM ETA	AC ETA	VMV	RMV		L21				ACOL11
CM ZET	AC ZET	VMW	RMW		L31				ACOL11
CL LOSS	G LOSS	PL LOSS	ML ALF		L32				ACOL11
CL FLUX	M PARA	CL LOSS	ML ALF		L33				ACOL11
					PL BET	T LOSS	SP IMP		TOT IM
	333.1700	688698.50	13523.757	6.27827	14898.237	5.49703	0.	98.526	0.
	286.3868	21599332.50	0.	8.50742	30153.818	0.98602	0.	9.664	0.
	27.5867	370.04	29732.160	0.18388	69.032	0.	0.867	0.	0.
-C.46912425-05	0.58601641+00	0.13883459+05	0.26212765+07	0.92125916+00	-0.36272482-00	-0.14038016-00	0.22889138+02		
C.18388209-00	0.	0.53856065+04	0.96248030+06	0.35970505-00	0.93186654+00	-0.47201902-01	0.68917670+02		
0.20777014-01	0.	-0.44572362+03	0.21418774+08	0.14793739-00	-0.70109852-02	0.58896953+00	0.81492583+02		
C.22115159+03	-0.22115159+03	0.49153366+04	0.57532395+02	0.56583121+02	0.51940205+04	0.42915993+03	0.71183435+08		
0.	0.57010513+08	0.15493238+03	0.43067639+03						
	334.0000	689917.50	13547.062	6.22767	14921.736	5.65198	0.	98.543	0.
	286.4198	21605556.00	0.	8.50705	30096.388	0.99088	0.	9.746	0.
	27.5823	371.82	29921.781	0.24368	69.345	0.	0.866	0.	0.
-C.57608368-04	0.95087576+00	0.13906744+05	0.26228507+07	0.92126135+00	-0.36272149-00	-0.14037429-00	0.22888815+02		
C.24367660-00	0.	0.53538851+04	0.96248030+06	0.35970505-00	0.93186654+00	-0.47201902-01	0.68917670+02		
0.20777014-01	0.	-0.44572362+03	0.21418774+08	0.14793739-00	-0.70109852-02	0.58896953+00	0.81492583+02		
C.22115159+03	-0.22115159+03	0.49153366+04	0.57532395+02	0.56583121+02	0.51940205+04	0.42915993+03	0.71183435+08		
0.	0.57010513+08	0.15493238+03	0.43067639+03						
	340.0000	698501.75	13710.866	5.87036	15095.883	5.33363	0.	98.667	0.
	286.6604	21605172.75	0.	8.03763	29674.375	1.02026	0.	9.872	0.
	27.5800	384.77	30275.543	0.07470	70.877	0.	0.891	0.	0.
-C.20018741-03	0.10202588+01	0.14061862+05	0.27167059+07	0.92220459+00	-0.36316671-00	-0.13282373-00	0.22749405+02		
C.74659472-01	0.	0.54554678+04	0.90951124+06	0.36052591-00	0.93169388+00	-0.44254728-01	0.68867256+02		
0.68718895-01	0.	-0.62256443+03	0.21414408+08	0.13982338-00	-0.70751464-02	0.99914879+00	0.81962371+02		
C.22115159+03	-0.22115159+03	0.49344347+04	0.61156825+02	0.60242185+02	0.52167820+04	0.42761602+03	0.71388834+08		
0.	0.57010513+08	0.15501461+03	0.42715408+03						
	350.0000	711940.00	14118.300	5.30463	15396.353	4.82866	0.	98.876	0.
	287.0681	21622687.00	0.	6.73989	28965.326	1.04589	0.	9.543	0.
	27.4942	406.74	30294.630	0.02035	70.932	0.	0.902	0.	0.
-C.35905621-04	0.10458920+01	0.14233004+05	0.28586590+07	0.92484769+00	-0.36349306-00	-0.11190905-00	0.22354600+02		
C.20351291-01	0.	0.55606744+04	0.10545816+07	0.36176948-00	0.93156611+00	-0.36069741-01	0.68791094+02		
-C.15535230-01	0.	-0.87851182+03	0.21404508+08	0.11736219-00	-0.71264172-02	0.99936117+00	0.83260106+02		
C.22115159+03	-0.22115159+03	0.49567188+04	0.66731425+02	0.65766010+02	0.52476017+04	0.42730849+03	0.71651680+08		
0.	0.57010513+08	0.15512532+03	0.42703298+03						
	360.0000	724317.00	14328.156	4.77109	15707.973	4.35114	0.	99.090	0.
	287.4845	21635102.50	0.	5.61316	28255.729	1.07283	0.	9.360	0.
	27.4358	428.20	30213.717	0.19290	70.987	0.	0.824	0.	0.
-C.20138302-04	0.10728343+01	0.14605198+05	0.30033305+07	0.92732503+00	-0.36232481-00	-0.93677735-01	0.21977784+02		
C.16389020-00	0.	0.56683924+04	0.11107269+07	0.36123108-00	0.93202227+00	-0.28083326-01	0.68824179+02		
0.10719861-00	0.	-0.11362771+04	0.21396822+08	0.57811466-01	-0.65623621-02	0.99517810+00	0.86386860+02		
C.22115159+03	-0.22115159+03	0.49819850+04	0.72258167+02	0.71286845+02	0.52753947+04	0.42720792+03	0.71994717+08		
0.	0.57010513+08	0.15527528+03	0.42703198+03						
	370.0000	735662.00	14649.760	4.26735	16031.137	3.89904	0.	99.306	0.
	287.9796	21646505.25	0.	4.57439	27545.583	1.10119	0.	9.243	0.
	27.3747	457.17	30732.004	0.23928	71.042	0.	0.766	0.	0.

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 0.19679441-03 0.15678302+01 0.19100423+05 0.53319371+07 0.90341038+00 -0.36459699-00 0.22563451-00 0.25389969+02
 -0.10048875-01 0. 0.74270605+04 0.20154477+07 0.35193219-00 0.93113517+00 0.95510638-01 0.69394457+02
 -0.69516014-01 0. 0.56845700+04 0.20947070+08 0.24492035-00 0.68773402-02 0.96951550+00 0.104117712+03
 0.22115159+03 0.57010513+08 0.50561777+04 0.11408691+03 0.11302463+03 0.53514160+04 0.43027516+03 0.76111058+08
 0. 0.57010513+08 0.15577602+03 0.43201984+03

499.1700 75684.75 19879.094 -0.30058 21267.387 -0.28096 0. 102.448 0.
 294.3135 21708784.25 0. 345.88287 18700.927 1.56783 0. 1.354 0.
 26.2742 801.66 29310.063 0. 67.867 0. 0.849 0.
 0.15679441-03 0.15678302+01 0.19100423+05 0.53319371+07 0.90341038+00 -0.36459699-00 0.22563451-00 0.25389969+02
 -0.10048875-01 0. 0.74270605+04 0.20154477+07 0.35193219-00 0.93113517+00 0.95510638-01 0.69394457+02
 -0.69516014-01 0. 0.56845700+04 0.20947070+08 0.24492035-00 0.68773402-02 0.96951550+00 0.104117712+03
 0.22115159+03 0.57010513+08 0.50561777+04 0.11408691+03 0.11302463+03 0.53514160+04 0.43027516+03 0.76111058+08
 0. 0.57010513+08 0.15577602+03 0.43201984+03

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 TIME ALTITUDE VELOCITY RA FLT PATH R VELOCITY I AXI LO FCTR NORM FORCE VEL R AZ DYNM PRS
 LONGITUDE R MAGNITUDE THRST FIXED PITCH ATT WEIGHT AXI LO FCTR NORM FORCE ALPHA DYNM PRS
 GEOCENT LAT GRND RANGE THRST CONTL PITCH RATE WEIGHT DOT PACH NUMBER SIDE FORCE BETA ATM PRS
 ENGLISH UNITS.

CM XI AC XI VMU RWU L11 L12 L13 ACOL11
 CM FTA AC FTA VMV RMV L21 L22 L23 ACOL12
 CM ZFT AC ZFT VPM RMW L31 L32 L33 ACOL13
 D LOSS G LOSS F LOSS M ALF PL BET T LOSS SP IMP V INFI
 FLUX H PARA DBLCS TESP SEMIR PERIAP V INFI
 PERAD PERALT PERVEL APPROV ORBINC TRU AN SEMIVA PERIAP V INFI
 APRAD APCALT APCVEL ECC AN PEANNA RINGANG LCNASH

499.1700 75684.75 19879.094 -0.30058 21267.387 -0.28096 0. 102.448 0.
 294.3135 21708784.25 0. 345.88287 18700.927 1.56731 0. 1.420 0.
 26.2742 801.66 29310.063 0. 67.867 0. 0.849 0.
 0.15679441-03 0.15678302+01 0.19100423+05 0.53319371+07 0.90341038+00 -0.36459699-00 0.22563451-00 0.25389969+02
 -0.10048875-01 0. 0.74270605+04 0.20154477+07 0.35193219-00 0.93113517+00 0.95510638-01 0.69394457+02
 -0.69516014-01 0. 0.56845700+04 0.20947070+08 0.24492035-00 0.68773402-02 0.96951550+00 0.104117712+03
 0.22115159+03 0.57010513+08 0.50561777+04 0.11408691+03 0.11302463+03 0.53514160+04 0.43027516+03 0.76111058+08
 0. 0.57010513+08 0.15577602+03 0.43201984+03
 0.11224505+03 0.57010513+08 0.15577602+03 0.43201984+03
 0.21709538+08 0.78364950+06 0.21266539+05 0.28567566+02 0.18064789+03 0.27453512-18 0.29155215+03 0.25993095+03
 0.11220741+03 0.36073005+04 0.35920654+04 0.18088534+03 0.18115314+03 0.15178791+02

570.0000 792636.00 20975.946 -0.76840 22363.756 -0.72071 0. 103.020 0.
 294.3135 21708784.25 0. 345.88287 18700.927 1.56731 0. 1.420 0.
 26.2742 801.66 29310.063 0. 67.867 0. 0.849 0.
 0.49674448-04 0.15720405+01 0.19132216+05 0.53478037+07 0.90341038+00 -0.36459699-00 0.22563451-00 0.25389969+02
 0.15387635-00 0. 0.74270605+04 0.20154477+07 0.35193219-00 0.93113517+00 0.95510638-01 0.69394457+02
 0.90746214-01 0. 0.57187252+04 0.20947070+08 0.24492035-00 0.68773402-02 0.96951550+00 0.104117712+03
 0.22115159+03 0.57010513+08 0.50561777+04 0.11408691+03 0.11302463+03 0.53514160+04 0.43027516+03 0.76111058+08
 0. 0.57010513+08 0.15577602+03 0.43201984+03
 0.11224505+03 0.57010513+08 0.15577602+03 0.43201984+03
 0.21709538+08 0.78364950+06 0.21266539+05 0.28567566+02 0.18064789+03 0.27453512-18 0.29155215+03 0.25993095+03
 0.11224505+03 0.36073005+04 0.35920654+04 0.18088534+03 0.18115314+03 0.15178791+02

570.0000 792636.00 20975.946 -0.76840 22363.756 -0.72071 0. 103.020 0.
 294.3135 21708784.25 0. 345.88287 18700.927 1.56731 0. 1.420 0.
 26.2742 801.66 29310.063 0. 67.867 0. 0.849 0.
 0.49674448-04 0.15720405+01 0.19132216+05 0.53478037+07 0.90341038+00 -0.36459699-00 0.22563451-00 0.25389969+02
 0.15387635-00 0. 0.74270605+04 0.20154477+07 0.35193219-00 0.93113517+00 0.95510638-01 0.69394457+02
 0.90746214-01 0. 0.57187252+04 0.20947070+08 0.24492035-00 0.68773402-02 0.96951550+00 0.104117712+03
 0.22115159+03 0.57010513+08 0.50561777+04 0.11408691+03 0.11302463+03 0.53514160+04 0.43027516+03 0.76111058+08
 0. 0.57010513+08 0.15577602+03 0.43201984+03
 0.11224505+03 0.57010513+08 0.15577602+03 0.43201984+03
 0.21709538+08 0.78364950+06 0.21266539+05 0.28567566+02 0.18064789+03 0.27453512-18 0.29155215+03 0.25993095+03
 0.11224505+03 0.36073005+04 0.35920654+04 0.18088534+03 0.18115314+03 0.15178791+02

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CASE 1	TRAJECTORY ID	-6 NOP	SECTION 6	PAGE 43
C.1381543+00	C.7316799+07	C.3564802+05	C.22915552-C0	-0.28230300+03
C.21713595+00	C.7068575+06	C.2058278+02	C.27453512-18	C.25904660+03
C.11394050+00	C.30312374+04	C.38591285+04	C.16377791+02	
530.0000	785245.75	21539.420	-0.99116	22923.144
256.1415	21701545.00	339.23703	1.76678	0.
25.8990	922.77	29550.997	0.24398	0.
C.74485031+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.24399170+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.43550000+02	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.22115150+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.14762760+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.21713515+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.11394072+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
540.0000	784916.25	22119.897	-1.21237	23507.017
256.1641	21607344.50	337.21195	1.83582	0.
25.7651	937.78	29252.834	0.16998	0.
C.74485794+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.16589746+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.16101180+01	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.22115150+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.16066646+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.21713515+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.11400050+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
550.0000	779606.75	22731.569	-1.43136	24116.165
257.4723	21652170.00	335.18473	1.93910	0.
25.6245	972.93	29577.129	0.25044	68.720
C.45265997+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.27599610+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.23164370+01	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.22115150+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.13567741+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.21713515+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.11394072+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
560.0000	773267.50	23769.382	-1.64854	24755.425
259.0568	21685571.75	333.17558	1.93910	0.
25.4770	1000.48	29423.578	0.22939	68.187
C.11394072+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.22115150+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.13567741+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.21713515+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.11394072+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
570.0000	76555.50	24740.788	-1.86310	25426.195
258.7283	21678775.00	331.21206	1.93910	0.
25.3221	1047.08	29410.212	0.22939	68.154
C.13567741+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.21713515+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.11394072+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
CASE 1	TRAJECTORY ID	-6 NOP	SECTION 6	PAGE 44
C.22115150+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.20514333+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.22254651+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.11394072+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
580.0000	75732.25	24742.495	-2.07319	26127.155
259.4176	21670326.25	329.24442	1.93910	0.
25.1554	1000.48	29364.504	0.20581	67.977
C.26254160+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.20514333+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.16300000+01	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.22115150+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.14762760+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.21713515+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.11394072+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
590.0000	747622.75	25480.034	-2.27789	26863.861
300.1254	21660789.75	327.37100	1.93910	0.
24.5883	1125.62	29229.783	0.08954	67.566
C.26254160+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.20514333+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.16300000+01	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.22115150+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.14762760+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.21713515+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.11394072+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
600.0000	736728.00	26252.537	-2.47213	27635.467
300.0526	21650064.00	325.81720	1.93910	0.
24.8085	1166.68	29132.848	0.16144	67.330
C.26254160+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.20514333+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.16300000+01	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.22115150+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.14762760+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.21713515+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.11394072+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
610.0000	724621.50	27072.636	-2.65907	28454.580
301.6702	21638134.25	324.29981	1.93910	0.
24.6192	1209.02	29343.595	0.10600	67.964
C.26254160+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.20514333+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.16300000+01	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.22115150+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.14762760+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.21713515+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.11394072+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
620.0000	711293.00	27939.546	-2.81997	29320.425
302.3693	21624990.25	322.90395	1.93910	0.
24.4199	1252.72	29143.767	0.10570	67.367
C.26254160+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.20514333+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.16300000+01	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.22115150+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.14762760+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.21713515+00	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00
C.11394072+03	C.17667770+01	C.20323645+05	C.87050460+00	-0.36718300+00

CASE 1	TRAJECTORY ID	-6 NCM	SECTION 6	PAGE 45
0.22722200-04	0.27762239+01	0.24583598+05	0.74297723+00	0.55930416+00
0.19567460-00	0.09577697+04	0.30348991+07	0.29915974+00	0.92994317+00
0.21733624-01	0.12799473+05	0.19879664+00	0.60315295+00	0.53502490+00
0.22115159+03	0.22115159+03	0.48881557+04	0.16596317+03	0.52752703+04
0.57010513+08	0.15512745+03	0.43261075+03	0.31833728+08	0.32374899+00
0.61853900+06	0.29420701+05	0.28497127+08	0.31833728+08	0.32374899+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.12014280+03	0.95118107+04	0.48564758+04	0.35211659+03	0.35466790+03
640.0000	696771.00	28856.753	-2.95803	30236.522
373.1617	21610667.25	0.0	321.86611	9827.515
24.2758	1297.86	29015.416	0.13362	66.985
0.44946229-04	0.29954671+01	0.25149918+05	0.81997880+07	0.73277386+00
0.19941534-00	0.0	0.97995753+04	0.31317706+07	0.28587669+00
0.58861304-02	0.0	0.13627770+05	0.19747818+08	0.23106312+00
0.22115159+03	0.22115159+03	0.48674760+04	0.18714720+03	0.56746362+02
0.57010513+08	0.15512745+03	0.43261075+03	0.17894395+03	0.52687047+04
0.61853900+06	0.29420701+05	0.28497127+08	0.31833728+08	0.32374899+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.12014280+03	0.95118107+04	0.48564758+04	0.35211659+03	0.35466790+03
640.0000	681119.00	29846.154	-3.07108	31224.760
373.9772	2159213.25	0.0	321.04596	9150.586
23.5981	1344.53	29432.123	0.02182	68.227
0.44715927-05	0.32164195+01	0.25756204+05	0.84542764+07	0.72419071+00
0.21874524-01	0.0	0.10037457+05	0.32309369+07	0.28333472+00
0.15757376-02	0.0	0.14520872+05	0.19667125+08	0.28686807+00
0.22115159+03	0.22115159+03	0.48659818+04	0.19562228+03	0.19440525+03
0.57010513+08	0.15512745+03	0.43261075+03	0.43138678+03	0.52627557+04
0.61853900+06	0.29420701+05	0.28497127+08	0.31833728+08	0.32374899+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.12014280+03	0.95118107+04	0.48564758+04	0.35211659+03	0.35466790+03
640.0000	664472.50	30912.996	-3.14219	32290.433
373.8154	21578725.75	0.0	320.60588	8472.83
23.7535	1392.88	29128.713	0.00052	67.320
0.43722200-04	0.34379075+01	0.26408035+05	0.87150634+07	0.71916841+00
0.19567460-00	0.0	0.10293125+05	0.33325754+07	0.28285172+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.22115159+03	0.22115159+03	0.48659818+04	0.19562228+03	0.19440525+03
0.57010513+08	0.15512745+03	0.43261075+03	0.43138678+03	0.52627557+04
0.61853900+06	0.29420701+05	0.28497127+08	0.31833728+08	0.32374899+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.12014280+03	0.95118107+04	0.48564758+04	0.35211659+03	0.35466790+03
640.0000	646872.25	32068.338	-3.15885	33444.643
373.6997	21561403.00	0.0	320.46119	7796.111
23.5061	1443.02	29364.788	0.00571	68.034
0.42727571-04	0.37655546+01	0.27115134+05	0.89826202+07	0.71840624+00
0.19567460-00	0.0	0.10571779+05	0.34368794+07	0.28039639+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.22115159+03	0.22115159+03	0.48659818+04	0.19562228+03	0.19440525+03
0.57010513+08	0.15512745+03	0.43261075+03	0.43138678+03	0.52627557+04
0.61853900+06	0.29420701+05	0.28497127+08	0.31833728+08	0.32374899+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.12014280+03	0.95118107+04	0.48564758+04	0.35211659+03	0.35466790+03
640.0000	646872.25	32068.338	-3.15885	33444.643
373.6997	21561403.00	0.0	320.46119	7796.111
23.5061	1443.02	29364.788	0.00571	68.034
0.42727571-04	0.37655546+01	0.27115134+05	0.89826202+07	0.71840624+00
0.19567460-00	0.0	0.10571779+05	0.34368794+07	0.28039639+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.22115159+03	0.22115159+03	0.48659818+04	0.19562228+03	0.19440525+03
0.57010513+08	0.15512745+03	0.43261075+03	0.43138678+03	0.52627557+04
0.61853900+06	0.29420701+05	0.28497127+08	0.31833728+08	0.32374899+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.12014280+03	0.95118107+04	0.48564758+04	0.35211659+03	0.35466790+03

CASE 1	TRAJECTORY ID	-6 NCM	SECTION 6	PAGE 46
0.43723542-04	0.41671347+01	0.27908077+05	0.92572828+07	0.72142617+00
0.19567460-00	0.0	0.11879496+05	0.35441066+07	0.28183807+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.22115159+03	0.22115159+03	0.48659818+04	0.19562228+03	0.19440525+03
0.57010513+08	0.15512745+03	0.43261075+03	0.43138678+03	0.52627557+04
0.61853900+06	0.29420701+05	0.28497127+08	0.31833728+08	0.32374899+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.12014280+03	0.95118107+04	0.48564758+04	0.35211659+03	0.35466790+03
640.0000	612084.00	34626.674	-2.99902	36000.960
373.4383	21527774.00	0.0	320.82805	6480.234
22.9904	1544.35	30015.546	0.00044	70.165
0.46319229+01	0.28712859+05	0.95145798+07	0.72166243+00	0.36877561+00
0.43984350-03	0.0	0.11197610+05	0.36443767+07	0.28321654+00
0.24855921-03	0.0	0.18627791+05	0.18963300+08	0.43164586+00
0.22115159+03	0.22115159+03	0.48659818+04	0.19562228+03	0.19440525+03
0.57010513+08	0.15512745+03	0.43261075+03	0.43138678+03	0.52627557+04
0.61853900+06	0.29420701+05	0.28497127+08	0.31833728+08	0.32374899+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.12014280+03	0.95118107+04	0.48564758+04	0.35211659+03	0.35466790+03
640.0000	612084.00	34626.674	-2.99902	36000.960
373.4383	21527774.00	0.0	320.82805	6480.234
22.9904	1544.35	30015.546	0.00044	70.165
0.46319229+01	0.28712859+05	0.95145798+07	0.72166243+00	0.36877561+00
0.43984350-03	0.0	0.11197610+05	0.36443767+07	0.28321654+00
0.24855921-03	0.0	0.18627791+05	0.18963300+08	0.43164586+00
0.22115159+03	0.22115159+03	0.48659818+04	0.19562228+03	0.19440525+03
0.57010513+08	0.15512745+03	0.43261075+03	0.43138678+03	0.52627557+04
0.61853900+06	0.29420701+05	0.28497127+08	0.31833728+08	0.32374899+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.12014280+03	0.95118107+04	0.48564758+04	0.35211659+03	0.35466790+03
640.0000	612084.00	34626.674	-2.99902	36000.960
373.4383	21527774.00	0.0	320.82805	6480.234
22.9904	1544.35	30015.546	0.00044	70.165
0.46319229+01	0.28712859+05	0.95145798+07	0.72166243+00	0.36877561+00
0.43984350-03	0.0	0.11197610+05	0.36443767+07	0.28321654+00
0.24855921-03	0.0	0.18627791+05	0.18963300+08	0.43164586+00
0.22115159+03	0.22115159+03	0.48659818+04	0.19562228+03	0.19440525+03
0.57010513+08	0.15512745+03	0.43261075+03	0.43138678+03	0.52627557+04
0.61853900+06	0.29420701+05	0.28497127+08	0.31833728+08	0.32374899+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.12014280+03	0.95118107+04	0.48564758+04	0.35211659+03	0.35466790+03
640.0000	611919.25	34643.235	-2.99837	36017.412
373.4468	21526511.50	0.0	320.82805	6454.262
22.5879	1544.85	30015.546	0.00044	507.019
0.46319229+01	0.28712859+05	0.95145798+07	0.72166243+00	0.36877561+00
0.43984350-03	0.0	0.11197610+05	0.36443767+07	0.28321654+00
0.24855921-03	0.0	0.18627791+05	0.18963300+08	0.43164586+00
0.22115159+03	0.22115159+03	0.48659818+04	0.19562228+03	0.19440525+03
0.57010513+08	0.15512745+03	0.43261075+03	0.43138678+03	0.52627557+04
0.61853900+06	0.29420701+05	0.28497127+08	0.31833728+08	0.32374899+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.12014280+03	0.95118107+04	0.48564758+04	0.35211659+03	0.35466790+03
640.0000	611919.25	34643.235	-2.99837	36017.412
373.4468	21526511.50	0.0	320.82805	6454.262
22.5879	1544.85	30015.546	0.00044	507.019
0.46319229+01	0.28712859+05	0.95145798+07	0.72166243+00	0.36877561+00
0.43984350-03	0.0	0.11197610+05	0.36443767+07	0.28321654+00
0.24855921-03	0.0	0.18627791+05	0.18963300+08	0.43164586+00
0.22115159+03	0.22115159+03	0.48659818+04	0.19562228+03	0.19440525+03
0.57010513+08	0.15512745+03	0.43261075+03	0.43138678+03	0.52627557+04
0.61853900+06	0.29420701+05	0.28497127+08	0.31833728+08	0.32374899+00
0.42135866+08	0.21214128+00	0.15729873+05	0.28559159+02	0.34898692+03
0.12014280+03	0.95118107+04	0.48564758+04	0.35211659+03	0.35466790+03

GDC-BTD66-012

[illegible]

CASE 1		TRAJECTORY ID		-6 NOV		SECTION 6		PAGE 49	
C.	C.	C.27733711+05	C.11454596+08	C.72166243+00	-C.36877561+00	C.58583018+00	C.43808095+02		
C.	C.	C.10828267+05	C.44010306+07	C.28321654+00	C.92950080+00	C.23623075+00	C.73547728+02		
C.	C.	-C.20475783+05	C.17621743+08	-C.63164586+00	-C.45620737+02	C.77523433+00	C.12917195+03		
C.22115159+03	-C.22115159+03	C.46712565+04	C.24961897+03	C.24834564+03	C.51420270+04	C.43041885+03	C.81391206+08		
C.10408098+03	C.57016878+08	C.15367946+03	C.						
C.21472275+08	C.54654124+06	C.36766224+05	C.42605124+08	C.13582219+10	C.98419155+00	-C.10363439+08	-C.32192297+04		
C.26550915+10	C.26741657+10	C.28734609+03	C.28559769+02	C.79293647+00	C.11086021+02	C.13102613+03	C.25890628+03		
C.13181918+03	C.26510432+07	C.13255133+07	C.70779115+01	C.11185735+02	C.34807967+02				
END DELAY									
747.0000	556507.75	34693.662	C.40892	36065.360	C.39336	C.	110.772	C.00	
313.8946	21473300.50	C.	320.82805	4367.716	C.	C.	-4.721	C.	
20.8723	1925.81	C.	C.	C.	C.	C.	C.950	C.	
C.	C.	C.27733711+05	C.11454596+08	C.72166243+00	-C.36877561+00	C.58583018+00	C.43808095+02		
C.	C.	C.10828267+05	C.44010306+07	C.28321654+00	C.92950080+00	C.23623075+00	C.73547728+02		
C.	C.	-C.20475783+05	C.17621743+08	-C.63164586+00	-C.45620737+02	C.77523433+00	C.12917195+03		
C.22115159+03	-C.22115159+03	C.46712565+04	C.24961897+03	C.24834564+03	C.51420270+04	C.43041885+03	C.81391206+08		
C.10408098+03	C.57016878+08	C.15367946+03	C.						
C.21472275+08	C.54654124+06	C.36766224+05	C.42605124+08	C.13582219+10	C.98419155+00	-C.10363439+08	-C.32192297+04		
C.26550915+10	C.26741657+10	C.28734609+03	C.28559769+02	C.79293647+00	C.11086021+02	C.13102613+03	C.25890628+03		
C.13181918+03	C.26510432+07	C.13255133+07	C.70779115+01	C.11185735+02	C.34807967+02				

CASE 1		TRAJECTORY ID		-6 NOV		SECTION 7		PAGE 50	
TIME	ALTITUDE	VELOCITY	RA	FLT PATH	R	VELOCITY I	AXL FORCE	VEL R AZ	PRM
LONGITUDE	R MAGNITUDE	THRST	FIXED	PITCH	ATT	WEIGHT	AXL LD	FCRTR	PRM
GECENT LAT	GRND RANGE	THRST	CONTL	PITCH	RATE	WEIGHT DCT	MACH NUMBER	SIDE FORCE	PRM
ENGLISH UNITS									
CP XI	AC XI	VMU	RMU	L11		L12		L13	ACOL11
CP FTA	AC FTA	VMV	RMV	L21		L22		L23	ACOL12
CP ZET	AC ZET	VMW	RMW	L31		L32		L33	ACOL13
D LOSS	G LOSS	M LOSS	ML ALF	PL RET		T LOSS		SP IMP	TOT IM
M FLUX	M PARA	DBLOSS	TIIS						
PERRAD	PERRAT	PERVEL	SEMILR	SEMIMA		ECCENT		VISVIV	V-INFI
APPRAC	APPCALY	APROVEL	ORBITAC	TRU AN		SEMIWA		PETIAP	LCNASH
PCARG	PERIOD	TIMEAP	ECC AN	MEANAN		RNGANG			
747.0000	556507.75	34693.662	C.40892	36065.360	C.39336	C.	110.772	C.00	
313.8946	21473300.50	C.	320.82805	4367.716	-C.31367	C.	-4.721	C.	
20.8723	1925.81	-1370.000	C.	C.	C.	C.	C.950	C.	
C.	C.	C.27733711+05	C.11454596+08	C.72166243+00	-C.36877561+00	C.58583018+00	C.43808095+02		
C.	C.	C.10828267+05	C.44010306+07	C.28321654+00	C.92950080+00	C.23623075+00	C.73547728+02		
C.	C.	-C.20475783+05	C.17621743+08	-C.63164586+00	-C.45620737+02	C.77523433+00	C.12917195+03		
C.22115159+03	-C.22115159+03	C.46712565+04	C.24961897+03	C.24834564+03	C.51420270+04	C.	C.81391206+08		
C.10408098+03	C.57016878+08	C.15367946+03	C.						
C.21472275+08	C.54654124+06	C.36766224+05	C.42605124+08	C.13582219+10	C.98419155+00	-C.10363439+08	-C.32192297+04		
C.26550915+10	C.26741657+10	C.28734609+03	C.28559769+02	C.79293647+00	C.11086021+02	C.13102613+03	C.25890628+03		
C.13181918+03	C.26510432+07	C.13255133+07	C.70779115+01	C.11185735+02	C.34807967+02				
748.0000	556552.00	34692.617	C.41897	36064.313	C.40303	C.	110.779	C.00	
313.5132	21473350.75	C.	320.82805	4367.716	C.	C.	-4.712	C.	
20.8658	1926.92	C.	C.	C.	C.	C.	C.950	C.	
C.	C.	C.27655725+05	C.11460137+08	C.72166243+00	-C.36877561+00	C.58583018+00	C.43808095+02		
C.	C.	C.10828267+05	C.44010306+07	C.28321654+00	C.92950080+00	C.23623075+00	C.73547728+02		
C.	C.	-C.20475783+05	C.17621743+08	-C.63164586+00	-C.45620737+02	C.77523433+00	C.12917195+03		
C.22115159+03	-C.22115159+03	C.46712565+04	C.24961897+03	C.24834564+03	C.51420270+04	C.	C.81391206+08		
C.10408098+03	C.57016878+08	C.15367946+03	C.						
C.21472275+08	C.54654124+06	C.36766224+05	C.42605124+08	C.13582219+10	C.98419155+00	-C.10363439+08	-C.32192297+04		
C.26550915+10	C.26741657+10	C.28734609+03	C.28559769+02	C.79293647+00	C.11086021+02	C.13102613+03	C.25890628+03		
C.13181918+03	C.26510432+07	C.13255133+07	C.70779115+01	C.11185735+02	C.34807967+02				
750.0000	557065.75	34692.168	C.51810	36063.854	C.49835	C.	110.851	C.00	
314.0983	21473518.00	C.	320.82805	4367.716	C.	C.	-4.618	C.	
20.8000	1938.04	C.	C.	C.	C.	C.	C.953	C.	
C.	C.	C.27667069+05	C.11515530+08	C.72166243+00	-C.36877561+00	C.58583018+00	C.43808095+02		
C.	C.	C.10794112+05	C.44247530+07	C.28321654+00	C.92950080+00	C.23623075+00	C.73547728+02		
C.	C.	-C.20440254+05	C.17576791+08	-C.63164586+00	-C.45620737+02	C.77523433+00	C.12917195+03		
C.22115159+03	-C.22115159+03	C.46712565+04	C.25163560+03	C.25036228+03	C.51431093+04	C.	C.81391343+08		
C.10408098+03	C.57016878+08	C.15367946+03	C.						
C.21472275+08	C.54654124+06	C.36766224+05	C.42605124+08	C.13490487+10	C.98408339+00	-C.10434368+08	-C.32302272+04		
C.26766251+10	C.26556994+10	C.28932765+03	C.28559840+02	C.10644903+01	C.11053258+02	C.13102613+03	C.25890628+03		
C.13272102+03	C.26740577+07	C.13120184+07	C.85971546+01	C.14320168+02	C.35019660+02				

MS DRIVEN

MSH. CMFGA C.75558779+00 C. 0. 0. 0.

MS DRIVEN

MSH. CMFGA C.20001221+00 C. 0.18755964+01 0.

760.0000	561433.50	34688.345	1.01363	36060.034	C.97507	C.	111.207	C.00
315.0213	21478555.00	C.	307.32416	4367.716	C.	C.	-17.656	C.

	20.4679	1993.62	0.	1.87560	0.	0.	0.	1.000	0.
0.	0.	0.27591484+05	0.11791349+00	0.56490777+00	-0.36877561+00	0.73215494+00	0.55604111+02		
0.12795966+01	0.	0.1739162+05	0.45324156+00	0.22922194+00	0.92950080+00	0.29583584+00	0.77277930+02		
0.	0.	-0.20798887+05	0.17379262+00	-0.79521783+00	-0.45629737+02	0.60629879+00	0.14267583+03		

PAGE 1	TRAJECTORY ID	-6 NOV	SECTION 7	PAGE 51
0.22115159+03	0.46677771+04	0.2516356+03	0.51403642+04	0.01351343+00
0.19466570+03	0.57118146+08	0.15373189+03	0.	
0.21472284+08	0.54654624+06	0.30065360+05	0.98479485+00	-0.10426864+0E -0.22290655+04
0.25857590+0E	0.26576511+10	0.28566154+07	0.11256774+02	0.13102776+03
0.17695367+03	0.2676994+07	0.13134315+07	0.27968055+02	0.25085443+03

770.0000	56288.75	34681.894	1.50890	36053.676	1.45148	111.957	0.00
325.1356	21486190.25	288.56564	0.	4367.716	0.	-35.946	0.
20.1307	2049.16	0.	1.87580	0.	201	0.	0.
P.	0.2733212605	0.12065521878	0.29756427-00	0.36877561-00	0.68959570-00	0.72688635+02	
C.	0.1664745057	0.46393614+07	0.11304088-00	0.92590700+00	0.35093567-00	0.83647367+02	
C.	-0.20545473705	0.171862623+08	-94.79371515-00	0.45620737-02	0.31840938-00	0.16143033+03	
C.	-0.46672321074	0.291836500+03	0.25036228003	0.51840792+04	0.	0.81391343+08	
C.	0.1211812605	0.2683331078	0.135979731-00	0.58410606+00	-0.10419520+08	-0.32279281+04	
C.	0.22115159+03	0.546552759+06	0.36065458+00	0.20763663+00	0.11260131+02	0.25801195+03	
C.	0.1747546805	0.1211812605	0.28893485+03	0.20763663+00	0.11260131+02	0.25801195+03	
C.	0.21477290+08	0.546552759+06	0.36065458+00	0.20763663+00	0.11260131+02	0.25801195+03	
C.	0.26874739+01	0.769545481+11	0.28893485+03	0.20763663+00	0.11260131+02	0.25801195+03	
C.	0.33055570+08	0.769545481+11	0.28893485+03	0.20763663+00	0.11260131+02	0.25801195+03	

780.0000	579157.50	34672.822	2.00377	36044.790	1.92747	0.	111.899	0.00
181.8528	2145618.25		285.62997	4367.716		0.	-54.256	0.00
15.7888	214.65		1.87540			0.	1.483	0.00
C.			0.2715090000	0.1233790000	-0.1382452000	-0.3687756100	0.9295112600	0.9007921100
C.			0.1567590000	0.4745703000	-0.5456480000	0.9295008000	0.3687673400	0.9031263400
C.			-0.2119657200	0.1691518600	-0.9999714400	0.4562073700	-0.3257163300	0.7902979000
C.			0.4666466200	0.2516356000	0.2503622800	0.5412224500		0.8139134000
C.			0.2211515600					
C.			0.1401184600					
C.			0.1742730200					
C.			0.7627306800					
C.			0.3491700000					
C.			0.2715090000	0.1233790000	-0.1382452000	-0.3687756100	0.9295112600	0.9007921100
C.			0.1567590000	0.4745703000	-0.5456480000	0.9295008000	0.3687673400	0.9031263400
C.			-0.2119657200	0.1691518600	-0.9999714400	0.4562073700	-0.3257163300	0.7902979000
C.			0.4666466200	0.2516356000	0.2503622800	0.5412224500		0.8139134000
C.			0.2211515600					
C.			0.1401184600					
C.			0.1742730200					
C.			0.7627306800					
C.			0.3491700000					
C.			0.2715090000	0.1233790000	-0.1382452000	-0.3687756100	0.9295112600	0.9007921100
C.			0.1567590000	0.4745703000	-0.5456480000	0.9295008000	0.3687673400	0.9031263400
C.			-0.2119657200	0.1691518600	-0.9999714400	0.4562073700	-0.3257163300	0.7902979000
C.			0.4666466200	0.2516356000	0.2503622800	0.5412224500		0.8139134000
C.			0.2211515600					
C.			0.1401184600					
C.			0.1742730200					
C.			0.7627306800					
C.			0.3491700000					
C.			0.2715090000	0.1233790000	-0.1382452000	-0.3687756100	0.9295112600	0.9007921100
C.			0.1567590000	0.4745703000	-0.5456480000	0.9295008000	0.3687673400	0.9031263400
C.			-0.2119657200	0.1691518600	-0.9999714400	0.4562073700	-0.3257163300	0.7902979000
C.			0.4666466200	0.2516356000	0.2503622800	0.5412224500		0.8139134000
C.			0.2211515600					
C.			0.1401184600					
C.			0.1742730200					
C.			0.7627306800					
C.			0.3491700000					
C.			0.2715090000	0.1233790000	-0.1382452000	-0.3687756100	0.9295112600	0.9007921100
C.			0.1567590000	0.4745703000	-0.5456480000	0.9295008000	0.3687673400	0.9031263400
C.			-0.2119657200	0.1691518600	-0.9999714400	0.4562073700	-0.3257163300	0.7902979000
C.			0.4666466200	0.2516356000	0.2503622800	0.5412224500		0.8139134000
C.			0.2211515600					
C.			0.1401184600					
C.			0.1742730200					
C.			0.7627306800					
C.			0.3491700000					
C.			0.2715090000	0.1233790000				

750.7900	55292.00	34661.141	2.49811	34033.384	2.40292	0.	112.294	0.00
317.7609	2151434.75		251.05252	4367.716	0.	-72.	72.527	0.
19.4418	2160.00		1.87560	0.	0.	3.310	0.	0.
0.	0.75982511+05	0.12609691+06	-0.30018234+00	-0.36877561+00	0.87970446+00	0.10744835+03		
0.127555964+1	0.15159966+05	0.48513447+07	-0.23738391+00	0.92950080+00	0.34742663+00	0.97107901+02		
0.22115154+03	-0.21435366+05	0.16778703+08	-0.19831661+00	0.45620737+02	-0.32465345-03	0.16105231+03		
0.17350342+03	0.46767070+04	0.2516356+03	0.25036228+03	0.51468686+04	0.	0.81391343+06		
0.21477231+03	0.56457503+06	0.1365108+03	0.26638101+08	0.1325756+10	0.58412738+00	-0.32257588+04		
0.26841768+10	0.26633181+10	-0.24851765+03	0.28561097+02	0.48445825+01	0.11066653+02	0.13103253+03		
0.13587715+03	0.26347599+07	0.13174359+07	0.43355111+00	0.48853875+02	0.38663391+02	0.25672707+03		

318.0000	680831.25	34646.863	2.99180	36019.472	2.87765	112.562	0.
318.4636	2152737.75	0.	232.29798	4367.616	0.	121.818	0.
19.4906	2215.43	1.87560	0.	0.	0.	124.112	0.
D.	0.	0.	0.	0.	0.	0.	0.
C.12715544+01	0.	0.	0.	0.	0.	0.	0.
C.21811515+00	0.	0.	0.	0.	0.	0.	0.
C.22115159+03	0.	0.	0.	0.	0.	0.	0.
C.27621725+08	0.	0.	0.	0.	0.	0.	0.
C.21472334+08	0.	0.	0.	0.	0.	0.	0.
C.26859176+10	0.	0.	0.	0.	0.	0.	0.
C.13843993+03	0.	0.	0.	0.	0.	0.	0.

PS DRIVER

MEM. CPFGA 0.55550760+00 0.

9.18755964401 C.

MS CRIVFA

SM. CPEEA C-12397766-04 0.

0.

0.

CASE 1	TRAJECTORY ID -6 AOP				SECTION 7	PAGE 52
900.0000	539249.75	34355.919	7.86305	35737.067	7.55735	0. 115.432 0.
327.3545	21854045.00	0.	147.89788	4291.815	C.01202	0. -170.438 0.
15.3876	2761.11	51.600	0.	2.760	0.	0. 178.869 0.
0.	0.12022884-C1	0.24831274+C5	0.15461852+C8	-0.78827511+C0	-0.36877561-C0	-0.49255227-C0 0.14202498+03
0.	0.	0.9697874+C4	0.59651836+C7	-0.31013829-C0	0.92950080+C0	-0.19957571-C0 0.10806756+03
0.	0.	0.72801218+C5	0.14245947+C8	0.53142586+C0	-0.45620737-C2	-0.84708320+C0 0.57897883+02
0.22115155+C3	-0.22115155+C3	0.48813150+C4	0.27254541+C3	0.27127615+C3	0.53750159+C4	0.19914598+02 0.81392745+08
0.	0.97021725+C8	0.15667894+C3	0.18655652+C2	0.	0.	0.
0.21472777+C8	0.54703874+C8	0.36055675+C5	0.42582175+C8	0.12688453+C1	0.98377652+C0	-0.11093552+C8 -0.3307584+04
0.25182178+C1	0.24952921+C10	0.30769016+C3	0.28564424+C2	0.15245566+C2	0.10743657+C2	0.13104705+C3 0.25826183+03
0.14626249+C3	0.23935634+C7	0.11566213+C7	0.14166576+C1	0.24116144-C01	0.49273955+C2	0.
1000.0000	1535353.25	33814.682	12.52533	35212.637	12.02048	0. 117.564 0.
335.3662	22458286.25	0.	147.89788	4057.505	C.00972	0. -166.249 0.
11.5056	3282.74	39.425	0.	1.555	0.	0. 178.741 0.
0.	0.57164463-C2	0.22638358+C5	0.17834373+C8	-0.78827511+C0	-0.36877561-C0	-0.49255227-C0 0.14202498+03
0.	0.	0.88498354+C4	0.68929306+C7	-0.31013829-C0	0.92950080+C0	-0.19957571-C0 0.10806756+03
0.	0.	0.25478029+C5	0.11778199+C8	0.53142586+C0	-0.45620737-C2	-0.84708320+C0 0.57897883+02
0.22115155+C3	-0.22115155+C3	0.52651304+C4	0.34532512+C3	0.34405156+C3	0.58673905+C4	0.20071600+02 0.81397448+08
0.	0.57021725+C8	0.15945012+C3	0.25345705+C2	0.	0.	0.
0.21472777+C8	0.54811150+C6	0.36015411+C5	0.42500808+C8	0.10318780+C1	0.97918874+C0	-0.13442175+C8 -0.36935316+04
0.20422722+C10	0.27212764+C10	0.37874574+C3	0.28567016+C2	0.24300387+C2	0.94466341+C01	0.13104645+C3 0.25784097+03
0.15534684+C3	0.17552614+C7	0.87738579+C6	0.25294593+C1	0.53445269-C01	0.58325433+C2	0.
1100.0000	2385272.75	33117.633	16.91210	34535.376	16.19634	0. 119.020 0.
342.5501	23300685.25	0.	147.89788	4005.329	C.00513	0. -162.159 0.
7.6550	3769.92	20.533	0.	0.493	0.	0. 178.405 0.
0.	0.51265739-C2	0.20364158+C5	0.19988024+C8	-0.78827511+C0	-0.36877561-C0	-0.49255227-C0 0.14202498+03
0.	0.	0.79798712+C4	0.77343870+C7	-0.31013829-C0	0.92950080+C0	-0.19957571-C0 0.10806756+03
0.	0.	0.26708559+C5	0.91651401+C7	0.53142586+C0	-0.45620737-C2	-0.84708320+C0 0.57897883+02
0.22115155+C3	-0.22115155+C3	0.58738399+C4	0.37895073+C3	0.37767760+C3	0.64739421+C4	0.23028992+02 0.81399557+08
0.	0.97021725+C8	0.16183867+C3	0.41621620+C2	0.	0.	0.
0.21472777+C8	0.54942574+C6	0.36021597+C5	0.42464922+C8	0.65000562+C9	0.57739685+C0	-0.14815856+C8 -0.38451370+04
0.18387172+C10	0.18577914+C10	0.41153016+C3	0.28568804+C2	0.32777520+C2	0.87818442+C1	0.13104811+C3 0.25742175+03
0.16782404+C3	0.15578582+C7	0.77578834+C6	0.36020675+C1	0.83736570-C1	0.66803392+C2	0.
1200.0000	3447252.00	32301.562	20.97533	33752.609	20.03394	0. 119.911 0.
349.1020	24372680.00	0.	147.89788	3958.327	C.00469	0. -158.417 0.
3.9904	4216.77	18.567	0.	0.447	0.	0. 178.460 0.
0.	0.46955333-C2	0.18156667+C5	0.21916790+C8	-0.78827511+C0	-0.36877561-C0	-0.49255227-C0 0.14202498+03
0.	0.	0.71284158+C4	0.84850804+C7	-0.31013829-C0	0.92950080+C0	-0.19957571-C0 0.10806756+03
0.	0.	0.27510184+C5	0.64554745+C7	0.53142586+C0	-0.45620737-C2	-0.84708320+C0 0.57897883+02
0.22115155+C3	-0.22115155+C3	0.65704356+C4	0.40935349+C3	0.40808038+C3	0.72094064+C4	0.25038674+02 0.81401462+08
0.	0.97021725+C8	0.16781228+C3	0.41567163+C2	0.	0.	0.
0.21472777+C8	0.55101550+C6	0.35855955+C5	0.42473462+C8	0.88693656+C9	0.57578540+C0	-0.15870528+C8 -0.35838333+04
0.17523571+C10	0.17314713+C10	0.44102150+C3	0.28569848+C2	0.40587193+C2	0.81361005+C1	0.13104567+C3 0.25700346+03
0.17163286+C3	0.13588496+C7	0.69896385+C6	0.46864184+C1	0.11863142-C0	0.74609787+C2	0.
1300.0000	4684393.00	31416.506	24.70116	32901.276	23.51769	0. 120.357 0.
354.9321	25610172.50	0.	147.89788	3915.992	C.00424	0. -155.044 0.
0.6056	4621.25	16.600	0.	0.400	0.	0. 178.307 0.
0.	0.42390273-C2	0.16123866+C5	0.23631541+C8	-0.78827511+C0	-0.36877561-C0	-0.49255227-C0 0.14202498+03
0.	0.	0.63248896+C4	0.91616787+C7	-0.31013829-C0	0.92950080+C0	-0.19957571-C0 0.10806756+03
0.	0.	0.27573393+C5	0.36731518+C7	0.53142586+C0	-0.45620737-C2	-0.84708320+C0 0.57897883+02
0.22115155+C3	-0.22115155+C3	0.73365144+C4	0.43660326+C3	0.43533016+C3	0.79942711+C4	0.26476152+02 0.81403171+08
0.	0.97021725+C8	0.16549416+C3	0.41499988+C2	0.	0.	0.

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C.21478530+C0 0.9527200+06 C.3557142+05 C.42404445+C0 C.83783800+C0 C.07436434+C0 C.16800976+C0 C.40908993+C0
C.16541974+C0 C.16332716+C0 C.46706411+C0 C.28577265+C2 C.47693041+C0 C.75143290+C1 C.13104067+C0 C.25638956+C0
C.17873353+C0 C.12843143+C0 C.64159691+C0 C.37668532+C1 C.15731474+C0 C.61710357+C2

1400.0000 4761848.25 30794.568 28.70886 32024.930 26.65609 0. 120.470 0.
C.1457 26987457.00 0. 147.89788 3078.591 0.00370 0. -152.036 0.
-2.4768 4984.20 14.960 0. 0.348 0. 178.146 0.
C.37027354+C0 C.14219906+C5 C.25147206+C0 C.78827911+C0 C.36877561+C0 C.49255227+C0 C.14202498+C0
C. 0. C.55854373+C4 C.97566575+C0 C.31013829+C0 C.92950080+C0 C.19957571+C0 C.10806756+C0
C. 0. C.28145782+C5 C.86915674+C0 C.53142586+C0 C.45620737+C2 C.84708320+C0 C.57897883+C2
C.22115159+C0 C.22115159+C3 C.91337161+C4 C.46046541+C3 C.45919231+C3 C.88153329+C4 C.27515384+C2 C.81408625+C0
C. 0. C.16484280+C3 C.35558517+C5 C.41264367+C0 C.8002642+C0 C.97319036+C0 C.17595071+C0 C.41944489+C0
C.21480423+C0 C.59468524+C6 C.35558517+C5 C.41264367+C0 C.8002642+C0 C.97319036+C0 C.17595071+C0 C.41944489+C0
C.15784724+C0 C.15576466+C0 C.48031094+C3 C.28577223+C2 C.54108523+C2 C.64841964+C1 C.13103406+C0 C.25616774+C0
C.18514255+C0 C.11483630+C7 C.59851497+C6 C.68188433+C1 C.19873657+C0 C.88119423+C2

1500.0000 7546137.25 29594.473 31.18174 31152.363 29.47235 0. 120.341 0.
C.48118 28474297.00 0. 147.89788 3046.389 0.00315 0. -146.370 0.
-5.1905 5308.28 12.120 0. 0.296 0. 177.981 0.
C.31510064+C0 C.12571001+C5 C.76481712+C0 C.78827911+C0 C.36877561+C0 C.49255227+C0 C.14202498+C0
C. 0. C.49198150+C4 C.10281360+C0 C.31013829+C0 C.92950080+C0 C.19957571+C0 C.10806756+C0
C. 0. C.28106407+C5 C.15468997+C7 C.53142586+C0 C.45620737+C2 C.84708320+C0 C.57897883+C2
C.22115159+C0 C.22115159+C3 C.89338169+C4 C.48073513+C3 C.47946203+C3 C.96357035+C4 C.28266591+C2 C.81408625+C0
C. 0. C.67021725+C8 C.16003709+C3 C.40945944+C2 C.77134756+C0 C.97214955+C0 C.18249240+C0 C.42719129+C0
C.21480387+C0 C.95664974+C6 C.35548153+C5 C.42366485+C0 C.59876724+C2 C.64387093+C1 C.13102777+C0 C.25574083+C0
C.15212135+C0 C.15002878+C0 C.50765532+C3 C.28568984+C2 C.59876724+C2 C.64387093+C1 C.13102777+C0 C.25574083+C0
C.14009459+C0 C.11345077+C7 C.56645196+C6 C.78303631+C1 C.24173369+C0 C.93881239+C2

1600.0000 9120694.00 28796.588 34.00973 30302.642 31.99690 0. 120.044 0.
C.9956 3045154.50 0. 147.89788 3814.338 0.00267 0. -147.019 0.
-7.6105 5597.05 10.200 0. 0.246 0. 177.811 0.
C.26768158+C0 C.10546412+C5 C.27653746+C0 C.78827911+C0 C.36877561+C0 C.49255227+C0 C.14202498+C0
C. 0. C.43248476+C4 C.10743070+C0 C.31013829+C0 C.92950080+C0 C.19957571+C0 C.10806756+C0
C. 0. C.27814567+C5 C.47579359+C7 C.53142586+C0 C.45620737+C2 C.84708320+C0 C.57897883+C2
C.22115159+C0 C.22115159+C3 C.87177462+C4 C.47579359+C7 C.53142586+C0 C.45620737+C2 C.84708320+C0 C.57897883+C2
C. 0. C.97021725+C8 C.16003709+C3 C.40945944+C2 C.77134756+C0 C.97214955+C0 C.18249240+C0 C.42719129+C0
C.21480374+C0 C.95664974+C6 C.35548153+C5 C.42366485+C0 C.59876724+C2 C.64387093+C1 C.13102777+C0 C.25574083+C0
C.14780727+C0 C.14571469+C0 C.52239033+C3 C.28568984+C2 C.59876724+C2 C.64387093+C1 C.13102777+C0 C.25574083+C0
C.14607827+C0 C.10977550+C7 C.54276536+C6 C.87936323+C1 C.32955257+C0 C.10370389+C3

1700.0000 10755689.25 27852.916 36.58407 29487.081 34.26154 0. 119.636 0.
C.12.7564 31675407.00 0. 147.89788 3797.136 0.00226 0. -144.969 0.
-9.7444 5854.31 8.600 0. 0.198 0. 177.641 0.
C.22688646+C0 C.96106870+C4 C.28681340+C0 C.78827911+C0 C.36877561+C0 C.49255227+C0 C.14202498+C0
C. 0. C.37672301+C4 C.11148570+C0 C.31013829+C0 C.92950080+C0 C.19957571+C0 C.10806756+C0
C. 0. C.27814567+C5 C.47579359+C7 C.53142586+C0 C.45620737+C2 C.84708320+C0 C.57897883+C2
C.22115159+C0 C.22115159+C3 C.10473636+C5 C.51170939+C3 C.51043629+C3 C.11206497+C5 C.29232618+C2 C.81408625+C0
C. 0. C.97021725+C8 C.16003709+C3 C.40945944+C2 C.77134756+C0 C.97214955+C0 C.18249240+C0 C.42719129+C0
C.21480384+C0 C.95664974+C6 C.35548153+C5 C.42366485+C0 C.59876724+C2 C.64387093+C1 C.13102777+C0 C.25574083+C0
C.14448882+C0 C.14739955+C1 C.53432550+C3 C.28568984+C2 C.59876724+C2 C.64387093+C1 C.13102777+C0 C.25574083+C0
C.20072775+C0 C.10519637+C7 C.57471943+C6 C.97086877+C1 C.32955257+C0 C.10370389+C3

MS DRIVER
MSM. CMEGA 0.7958779+00 C. 0. 0.
MS DRIVER
MSM. CMEGA 0.2001221-00 C. 0. 0.

1800.0000 12437461.25 27400.193 38.94518 28711.899 36.29755 0. 119.157 0.
C.16.1465 33360339.00 0. 147.89788 3779.735 0.00185 0. -143.129 0.
-11.6218 6083.79 7.000 0. 0.150 0. 177.470 0.

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C. 0. C.18519817+C0 C.84104338+C4 C.29588113+C0 C.78827911+C0 C.36877561+C0 C.49255227+C0 C.14202498+C0
C. 0. C.33308485+C4 C.11804488+C0 C.31013829+C0 C.92950080+C0 C.19957571+C0 C.10806756+C0
C. 0. C.27249645+C5 C.10272065+C0 C.53142586+C0 C.45620737+C2 C.84708320+C0 C.57897883+C2
C.22115159+C0 C.22115159+C3 C.11154853+C5 C.52333552+C3 C.52206242+C3 C.11939339+C5 C.29622158+C2 C.81408625+C0
C. 0. C.97021725+C8 C.16003709+C3 C.40945944+C2 C.77134756+C0 C.97214955+C0 C.18249240+C0 C.42719129+C0
C.21480466+C0 C.56267875+C6 C.35525184+C5 C.42335917+C0 C.72055577+C0 C.97017823+C0 C.19535527+C0 C.44199013+C0
C.14156312+C0 C.13480754+C1 C.54378457+C3 C.28568190+C2 C.75899710+C2 C.52925111+C0 C.13101471+C0 C.25449521+C0
C.20491442+C0 C.10243230+C7 C.51135881+C6 C.10574378+C2 C.37346701+C0 C.10789011+C0

1853.0000 13356880.00 26620.897 40.13689 28312.432 37.30827 0. 118.881 0.
C.17.8330 34279256.50 0. 147.89788 3771.663 0.00186 0. -142.243 0.
-12.5367 6196.96 7.000 0. 0.150 0. 177.379 0.
C.18559449+C0 C.78239091+C4 C.30017659+C0 C.78827911+C0 C.36877561+C0 C.49255227+C0 C.14202498+C0
C. 0. C.31028597+C4 C.11677486+C0 C.31013829+C0 C.92950080+C0 C.19957571+C0 C.10806756+C0
C. 0. C.27032435+C5 C.11732294+C0 C.53142586+C0 C.45620737+C2 C.84708320+C0 C.57897883+C2
C.22115159+C0 C.22115159+C3 C.11567348+C5 C.52890392+C3 C.52763082+C3 C.12317403+C5 C.29763003+C2 C.81408625+C0
C. 0. C.97021725+C8 C.16003709+C3 C.40945944+C2 C.77134756+C0 C.97214955+C0 C.18249240+C0 C.42719129+C0
C.21480456+C0 C.56371775+C6 C.35522091+C5 C.42332918+C0 C.71485846+C0 C.96993887+C0 C.19691344+C0 C.44374929+C0
C.14082275+C0 C.13873017+C1 C.54816867+C3 C.28567871+C2 C.75982239+C2 C.51360324+C1 C.13101338+C0 C.25427011+C0
C.20665562+C0 C.10121899+C7 C.50457834+C6 C.11021934+C2 C.39714664+C0 C.10497102+C3

1853.0000 13356880.00 26620.897 40.13689 28312.432 37.30827 0. 118.881 0.
C.17.8330 34279256.50 0. 147.89788 3771.663 0.00186 0. -142.243 0.
-12.5367 6196.96 7.000 0. 0.150 0. 177.379 0.
C.18559449+C0 C.78239091+C4 C.30017659+C0 C.78827911+C0 C.36877561+C0 C.49255227+C0 C.14202498+C0
C. 0. C.31028597+C4 C.11677486+C0 C.31013829+C0 C.92950080+C0 C.19957571+C0 C.10806756+C0
C. 0. C.27032435+C5 C.11732294+C0 C.53142586+C0 C.45620737+C2 C.84708320+C0 C.57897883+C2
C.22115159+C0 C.22115159+C3 C.11567348+C5 C.52890392+C3 C.52763082+C3 C.12317403+C5 C.29763003+C2 C.81408625+C0
C. 0. C.97021725+C8 C.16003709+C3 C.40945944+C2 C.77134756+C0 C.97214955+C0 C.18249240+C0 C.42719129+C0
C.21480456+C0 C.56371775+C6 C.35522091+C5 C.42332918+C0 C.71485846+C0 C.96993887+C0 C.19691344+C0 C.44374929+C0
C.14082275+C0 C.13873017+C1 C.54816867+C3 C.28567871+C2 C.75982239+C2 C.51360324+C1 C.13101338+C0 C.25427011+C0
C.20665562+C0 C.10121899+C7 C.50457834+C6 C.11021934+C2 C.39714664+C0 C.10497102+C3

APPENDIX C

DESCRIPTION OF COORDINATE SYSTEMS AND TRAJECTORY PARAMETERS
APPLICABLE TO APPENDIXES A AND BC.1 DESCRIPTION OF COORDINATE SYSTEMS AND MATRICESC.1.1 Space-Fixed Coordinate System

U, V, W A space-fixed, right-handed Cartesian coordinate system with the W axis aligned with the plumb line at the launch pad and the U axis pointing in the launch direction. These axes are space fixed at guidance to inertial. The origin of the coordinate system is earth-centered.

C.1.2 Vehicle Axes Coordinate System

XI, ETA, ZETA A right-hand Cartesian coordinate system denoting the vehicle's fixed axes. The longitudinal (XI) axis is positive toward the front of the vehicle. The yaw (ZETA) axis is positive toward the No. 1 booster engine, or pod No. 1, and points up in flight. The pitch (ETA) axis is positive to the left when viewing the vehicle from its base.

C.1.3 Transformational Operator

L11	L12	L13	Cos (XI, U) Cos (ETA, U) Cos (ZETA, U)
L21	L22	L23	Cos (XI, V) Cos (ETA, V) Cos (ZETA, V)
L31	L32	L33	Cos (XI, W) Cos (ETA, W) Cos (ZETA, W)

A transformational operator that defines the relationship between the XI, ETA, ZETA, or vehicle axes and the inertial reference system.

C.2 OUTPUT OPTION 2

<u>Parameter</u>	<u>Definition</u>	<u>Units</u>
TIME	Time from liftoff (Appendix B) or time from guidance to inertial (Appendix A)	sec
ALTITUDE	Geocentric altitude above reference ellipsoid	ft
VELOCITY RA	Relative velocity referenced to a coordinate system fixed with respect to the air	ft/sec
FLT PATH R	Angle between the relative velocity vector and the local horizontal plane ⁽¹⁾ , measured positive above and negative below the horizontal plane	deg
VELOCITY I	Inertial velocity relative to inertial coordinate system, U, V, W	ft/sec
FLT PATH I	Angle between the inertial velocity vector and the local horizontal plane ⁽¹⁾ , measured positive above and negative below the horizontal plane	deg
AXL FORCE	Aerodynamic force along the vehicle's longitudinal axis	lb
VEL R AZ	Relative velocity azimuth angle, defined as the angle measured east of north to the projection of the relative velocity vector on the local horizontal plane ⁽¹⁾	deg
DYNM PRS	Dynamic pressure	lb/ft ²
LONGITUDE	Longitude, positive east of Greenwich meridian	deg
R MAGNITUDE	Magnitude of geocentric position vector	ft
THRST FIXED	Nongimbaled thrust	lb
PITCH ATT	Angle between the vehicle longitudinal axis and a space-fixed plane, U-V plane, measured positive above and negative below the reference plane	deg

(1) Local horizontal plane is defined as a plane normal to the geocentric position vector

<u>Parameter</u>	<u>Definition</u>	<u>Units</u>
WEIGHT	Weight of the vehicle	lb
AXL LD FCTR	Axial load factor, the longitudinal component of thrust less drag divided by weight	N. D.
NORM FORCE	Aerodynamic force in the pitch plane acting normal to the vehicle longitudinal axis and applied at the center of pressure	lb
ALPHA	Angle of attack in the pitch plane (XI-ZETA plane)	deg
ATM PRS	Atmospheric pressure	lb/ft ²
GEOCENT LAT	Geocentric latitude, positive north of equator and negative south of equator	deg
GRND RANGE	Surface range from launch pad to the sub vehicle point	n. mi.
THRST CONTL	Gimbaled thrust	lb
PITCH RATE	Time rate of change of PITCH ATT (see PITCH ATT)	deg/sec
WEIGHT DOT	Total flow rate	lb/sec
MACH NUMBER	Mach number	N. D.
SIDE FORCE	Aerodynamic force in the yaw plane acting normal to the vehicle longitudinal axis and applied at the center of pressure	lb
BETA	Angle of attack in the yaw plane (XI-ETA plane)	deg
REY NUMB	Reynolds number	ft ⁻¹

C.3 OUTPUT OPTION 9

<u>Parameter</u>	<u>Definition</u>	<u>Units</u>
OMG XI	The roll rate about the XI axis, positive roll rate results in right-hand screw rotation	deg/sec
OMG ETA	The pitch rate about the ETA axis, positive pitch rate results in right-hand screw rotation	deg/sec
OMG ZETA	The yaw rate about the ZETA axis, positive yaw rate results in right-hand screw rotation	deg/sec
AC XI AC ETA AC ZETA	Axial components of acceleration due to thrust and aerodynamic forces $\left(\frac{\text{thrust} - \text{aero force}}{\text{mass}} \right)$ along the vehicle axes.	ft/sec ²
RMU, RMV, RMW	The components of a position vector originating at the earth center, referenced to the space-fixed coordinate system	ft
VMU, VMV, VMW	The time rate of change of RMU, RMV, RMW	ft/sec
ACOL11	Angle whose cosine is L11 (XI, U)	deg
ACOL12	Angle whose cosine is L12 (XI, V)	deg
ACOL13	Angle whose cosine is L13 (XI, W)	deg

C.4 OUTPUT OPTION 12

<u>Parameter</u>	<u>Definition</u>	<u>Units</u>
G LOSS	Gravity loss, time integral from liftoff of gravity vector component along the inertial velocity vector	ft/sec
D LOSS	Drag loss, time integral from liftoff of all aerodynamic force accelerations along the inertial velocity vector	ft/sec
M LOSS	Misalignment loss, time integral from liftoff of magnitude of thrust acceleration less thrust acceleration vector component along the inertial velocity vector	ft/sec
T LOSS	Total losses, sum of gravity loss, drag loss, and misalignment loss	ft/sec
SP IMP	Average specific impulse in a section of trajectory simulation (not of a stage if it is simulated by several contiguous sections), quotient of time integral from beginning of section of total thrust and total flow rate	sec
TOT IM	Total impulse, time integral from liftoff of total thrust	lb-sec
H FLUX	Product of dynamic pressure and velocity relative to the air	ft-lb/ft ² -sec
H PARA	Heating parameter, time integral from lift-off of the product of dynamic pressure and velocity relative to the air	ft-lb/ft ²
ML ALF	Time integral from liftoff of the magnitude of the thrust acceleration component in the instantaneous trajectory plane ($\bar{R} \times \bar{V}$) less thrust acceleration vector component along the inertial velocity vector	ft/sec

<u>Parameter</u>	<u>Definition</u>	<u>Units</u>
ML BET	Time integral from liftoff of the magnitude of the thrust acceleration less thrust acceleration vector component in the instantaneous trajectory plane ($\bar{R} \times \bar{V}$)	ft/sec
DB LOSS	Defined by the equation $DB\ LOSS = 23.14 + 20 \log_{10} (\text{Slant Range}),$ where slant range is the range to the vehicle from a tracker with a 5-degree elevation angle to the vehicle	db
IISP	Instantaneous specific impulse, quotient of total thrust and total flow rate	sec

C. 5 OUTPUT OPTION 13

<u>Parameter</u>	<u>Definition</u>	<u>Units</u>
PER RADIUS	Minimum distance in a conic from the primary focus	ft
PERIGEE ALT	Minimum altitude in a conic above a reference sphere of equatorial radius of the earth	ft
PERIGEE VEL	Velocity at the minimum distance from the primary focus	ft/sec
APO RADIUS	Maximum distance in a conic from the primary focus	ft
APOGEE ALT	Maximum altitude in a conic above a reference sphere of equatorial radius of the earth	ft
APOGEE VEL	Velocity at the maximum distance from the primary focus	ft/sec
SEMILAT REC	Perpendicular distance from a point on the conic to the major axis at the primary focus	ft
SEMIMAJ AXIS	Semimajor axis of a conic	ft
ECCENTRICITY	Constant ratio in a conic of the distance from a point on the conic to the focus, to the distance from the point to the directrix	N. D.
PERIOD	Period of revolution	sec
SEMIVERTEX	Semivertex angle between asymptotes of hyperbola	deg
ORBITAL INCL	Dihedral angle between orbit plane and equatorial plane	deg
PERIAP ARG	Angle measured in the plane of orbit from the ascending node to periapsis	deg
LON-ASC-NOD	Angular distance measured in the equatorial plane from the earth-fixed launch longitude to the ascending node	deg

<u>Parameter</u>	<u>Definition</u>	<u>Units</u>
POSITION ARG	Angle at the primary focus between the ascending node and the position vector measured in the direction of motion	deg
VIS-VIVA EN	Twice the total energy per unit mass equal to the square of the hyperbolic excess velocity	(ft/sec) ²
V-INFINITY	Hyperbolic excess velocity	ft/sec
TRUE ANOMALY	Angle at the primary focus between per-iapsis and the position vector measured in the direction of motion	deg
TIMEAP	Conic coast time to apogee	sec
ECC AN	Eccentric anomaly	deg
MEAN AN	Mean anomaly	deg
RNGANG	Range angle, angle between the launch vector and the vehicle position vector	deg

C. 6 DETAILED PROPULSION (DEPRO) OUTPUT PARAMETERS

<u>Parameter</u>	<u>Definitions</u>	<u>Units</u>
NPSH	Net positive suction head at sustainer engine pump inlet	ft
MIX	Oxidizer to fuel burning mixture ratio	N. D.
W. B.	Total booster engine flow rate	lb/sec
W. S.	Total sustainer engine flow rate	lb/sec
WF	Fuel remaining above sustainer engine pump inlet	lb
WO	Oxidizer remaining above sustainer engine pump inlet	lb
VALVE ANGLE	Propellant utilization control valve setting	deg
ACS	Axial load factor, the longitudinal component of thrust less drag divided by weight	N. D.
PIPFB	Booster fuel pump inlet pressure	lb/in ² ambien
PIPOB	Booster oxidizer pump inlet pressure	lb/in ² ambient
PIPFS	Sustainer fuel pump inlet pressure	lb/in ² ambient
PIPOS	Sustainer oxidizer pump inlet pressure	lb/in ² ambient
FUEL DENS	Fuel density	lb/ft ³
OXID DENS	Oxidizer density	lb/ft ³
FUEL LEVEL	Fuel level from reference line	in
OXID LEVEL	Oxidizer level from reference line	in
W. FB	Booster engine fuel flow rate	lb/sec
W. OB	Booster engine oxidizer flow rate	lb/sec
W. FS	Sustainer engine fuel flow rate	lb/sec
W. OS	Sustainer engine oxidizer flow rate	lb/sec

<u>Parameter</u>	<u>Definitions</u>	<u>Units</u>
W. FV	Vernier engine fuel flow rate	lb/sec
W. OV	Vernier engine oxidizer flow rate	lb/sec
W. F	Total fuel flow rate	lb/sec
W. O	Total oxidizer flow rate	lb/sec
TH INC	Sustainer thrust increment as a function of valve angle change	lb
FUEL INC	Sustainer fuel flow increment as a function of valve angle change	lb
LO ₂ INC	Sustainer LO ₂ flow increment as a function of valve angle change	lb
CAPF	Capacitance output from fuel manometer in detailed propellant utilization simulation	$\mu\mu f$
CAPO	Capacitance output from oxidizer manometer in detailed propellant utilization simulation	$\mu\mu f$
CAP RATIO	CAPF divided by CAPO	N. D.
IGFP	Fuel pressure at fuel manometer port at one-g acceleration	psi
MIXRS	Sustainer engine mixture ratio	N. D.
PG(O)	Liquid oxygen tank gas pressure	psig
PG(F)	Fuel tank gas pressure	psig
PVPO	Liquid oxygen vapor pressure	psia
PSUBA	Ambient pressure as a function of altitude	psia
B MIX R	Booster engine mixture ratio after calculation of flow rates from influence coefficients	N. D.
B TH INC	Change in thrust from C STAR table	lb
B FU INC	Change in fuel flow rates from C STAR table	lb
B OX INC	Change in LO ₂ flow rates from C STAR table	lb

<u>Parameter</u>	<u>Definition</u>	<u>Units</u>
WBOI	Weight of booster engine lube oil	lb
WSOI	Weight of sustainer engine lube oil	lb
WBHE	Weight of booster helium ⁽¹⁾	lb
WSHE	Weight of sustainer helium ⁽²⁾	lb
EDO	Error demodulator output ⁽²⁾	vdc

(1) For the simulation, Appendix A, WBHE represents gaseous oxygen

(2) Not simulated

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