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GEMINI RENDEZVOUS MISSION ERROR ANALYSIS RESULTS M=4 [U]

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GEMINI RENDEZVOUS MISSION
ERROR ANALYSIS RESULTS
M = 4 (U)

July 1, 1965

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ABSTRACT

This report presents data and results obtained from error analysis runs of the Mission Plan II, fourth apogee (M = 4) Gemini rendezvous mission. Analysis of these data and run results indicates that the following maneuver sequence will be required for the mission:

Height Adjustment (NH)	M = 1.5
Catch-up Rate Adjustment (NCI)	M = 2.0
Plane Change (NPC)	M ≈ 2.5
Co-elliptic Maneuver (NSR)	M = 3.0

A fuel allowance of 380 feet/sec. should be provided in the Spacecraft for midcourse maneuvers. This allowance includes 240 feet/sec. for the NPC maneuver. The desired values of in-plane phase angle, height difference, and out-of-plane angle after the NSR maneuver should be obtained within 0.1 degrees, 1.5 n. mi., and 0.015 degrees, respectively. The vehicles' apsis lines should be aligned to within 4 degrees following the NSR maneuver. Good tracking information is available for determination of each in-plane maneuver, if voice command stations are used to command the NCI and NSR maneuvers. All plane changes, however, will be determined on the basis of tracking information prior to the NCI maneuver and will be performed without updated tracking information after the NCI maneuver. On the basis of the study results it does not appear that this will be a serious problem.

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INTRODUCTION

This report presents data and results obtained from analysis of the TRW/STL Gemini Closed-Loop Systems Simulation error analysis runs for the Mission Plan II, fourth apogee (M = 4) rendezvous mission. This study was conducted under contract NAS 9-2938 in accordance with Study 2 of the Gemini Error Analyses Task Assignment (Reference 1). In the original Task Assignment, error analyses studies were to be performed for M = 6, 8, 10, 12, 16, 24 and 30 rendezvous missions. The M = 4 error analysis study had been done previously and the results presented in Reference 2. The M = 4 mission was added to this study when it was decided to include Agena injection errors in the study and utilize a 15 n. mi. height difference between the Spacecraft and Agena following the NSR maneuver. A 20 n. mi. height difference value was used in the study of Reference 2.

The purpose of the Study 2 mission error analysis studies is to determine the effects of vehicle injection errors, maneuver execution errors, and tracking and command network operations on the mission maneuver sequence, velocity requirements, and vehicle relative position and velocity following the NSR maneuver at the M - 1 Spacecraft apogee. The Spacecraft and Agena relative position and velocity data after the NSR maneuver are then used by McDonnell Aircraft (MAC) and the Mission Planning and Analysis Division (MPAD) of the Manned Spacecraft Center (MSC) for analysis of the Gemini terminal rendezvous guidance system for the specific mission being studied.

The results and data presented in this report were obtained from analysis of a nominal and fifteen noise runs for the M = 4 rendezvous mission. The nominal run was made with no error sources simulated, but the velocity increment required for an orbital maneuver was rounded off to the nearest foot/sec and the time to initiate the maneuver to the nearest second. The noise runs, however, included injection errors, orbit determination errors, and maneuver execution errors for both the Spacecraft and the Agena. All of the latest modifications (Reference 3) to the Gemini Simulation Orbit Control Logic (OCL) were included in the runs, so that all maneuvers, including the NSR maneuver, are realistically simulated.

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Section 1.0 presents a brief description of the Simulation used for this study. How the Agena and Spacecraft "run nominal" orbits are selected to initiate a simulation run, discussion of the maneuvers that can be commanded by the OCL during a mission simulation run, and a brief discussion of Simulation output are included in this Section.

Section 2.0 presents the results obtained from analysis of the 16 computer runs. Maneuver sequences, tracking and command problems, midcourse velocity requirements and similar subjects are discussed in this Section, together with the presentation of a set of conclusions and recommendations regarding the mission.

Section 3.0 contains the Tables of Data which have been extracted from the simulation runs. These tables present a concise compilation of pertinent mission information contained in the extensive print-outs of the simulation runs.

Section 4.0 presents the compiled statistical output format (SOPFMT) for the 15 Closed-Loop runs. These data include the Agena-Spacecraft relative position and velocity data after the NSR maneuver, which are required for the terminal rendezvous guidance simulations conducted by McDonnell and MSC/MPAD.

Similar reports will be presented for the M = 6, 8, 10, 12, 16, 24, and 30 rendezvous mission studies when they are completed.

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1.0 DISCUSSION OF SIMULATION

This Section presents a brief discussion and description of the Gemini Closed-Loop Systems Simulation which was used to obtain the results presented herein. The Simulation used is basically the same as described in References 2, 4 and 5, but includes the modifications noted in Reference 3. These modifications, which are primarily Orbit Control Logic (OCL) changes, provide the capability to include differential nodal regression in plane change (NPC) maneuvers, perform catch-up rate adjustment maneuvers (NCl and NCH maneuvers) anticipating a future height adjustment maneuver, and perform the desired NSR maneuver (making vehicle orbits co-elliptical) at the M-1 Spacecraft apogee. Therefore, the conditions after the NSR maneuver obtained from these runs should provide a realistic set of initial conditions for the McDonnell and MSC terminal rendezvous guidance studies for this mission.

1.1 Run Initialization Procedure

The Agena and Spacecraft injection data used for the M = 4 mission simulation were obtained from MSC (Reference 6). For the nominal run, these data define the initial orbits of the two vehicles and these orbits remain unchanged except for vehicle maneuvers and perturbations due to drag and earth oblateness. For the noise runs, however, the effect of vehicle injection errors are considered and different "run nominal" initial orbits are obtained for the two vehicles for each of the 15 noise runs.

The Agena "run nominal" orbit is obtained by integrating the nominal specified injection conditions to 11.0 seconds after the specified time of injection. The Agena injection covariance matrix is then used to obtain a set of position and velocity injection errors. These errors are added to the nominal values at t_{inj} plus 11.0 seconds with the resultant Agena orbit being the "run nominal" orbit. This orbit is then integrated throughout the mission and provides the true position and velocity data for comparison with the orbit fit position and velocity data. The same procedure is followed with the Spacecraft, except the injection errors are added at 380 seconds after Spacecraft liftoff.

1.2 Determination and Performance of Required Maneuvers

In the Gemini Simulation, the OCL Decision Sequencer (DS) schedules required maneuvers and the Guidance Decision and Command Computations (GD & CC) determine whether or not a scheduled maneuver should be performed. For Closed-Loop runs, the OCL maneuver decisions are based on vehicle state vectors obtained from the orbit determination performed for each vehicle and the logic constants specified

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in the OCL. In this manner the OCL makes maneuver decisions on the basis of what it thinks the vehicle orbits are, and not on the vehicles' true orbits.

When a maneuver is required, a powered flight iteration is performed to derive command values of time to initiate the burn, velocity-to-be-gained, and vehicle attitudes and attitude rates at initiation of the burn. This iteration is performed using the orbit fit position and velocity data with no vehicle maneuver execution errors. The actual maneuver for the mission simulation run is then executed using the true position and velocity of the vehicle with execution errors added to the derived command parameters specifying the maneuver. Execution errors are also added to the vehicle weight, thrust, and weight flow rate for each maneuver. When all required maneuvers have been performed, the vehicle orbits are integrated to the M Spacecraft apogee number and the simulation is ended.

1.3 Allowable Maneuvers

For the M = 4 rendezvous mission, the OCL constants have been selected so that only 10 of the possible 21 maneuvers available to the OCL can be performed. These maneuvers are defined within the OCL by Operation Numbers and each maneuver performed during a simulation run is identified by an OP-No. in the run print-out. The maneuvers allowed for the M = 4 mission study are OP-8, 9, 10, 11, 12, 13, 14, 16, 17 and 21. These numbers are used in the data tables of Section 3.0 extensively to identify the maneuver sequences for each run, ΔV required for each maneuver for a run, and other pertinent mission information. The correlation between OP-No. and type of maneuver is presented below. The MSC/MPAD nomenclature for identifying types of Gemini maneuvers is used where applicable.

OP-No.	Function	MSC/MPAD Designation
8	Raise Spacecraft apogee to acceptable value	----
9	Agena plane change	NPC
10	Catch-up rate adjustment (raise perigee)	NC1
11	Agena orbit correction, perigee too low	----
12	Agena orbit correction, apogee too high	----
13	Spacecraft plane change	NPC

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14	Spacecraft apogee radius adjustment (height matching maneuver)	NH
16	Catch-up rate adjustment (raise perigee)	NC1
17	Catch-up rate adjustment (raise perigee)	NC1
21	Make orbits co-elliptic	NSR

In the plane change maneuvers, OP-9 or OP-13, differential nodal regression effects are included. For the catch-up rate adjustment maneuvers, OP-10, OP-16 or OP-17, the catch-up rate is altered to obtain a specified phase angle at the M-1 Spacecraft apogee. In order for OP-8, OP-11, or OP-12 to be performed, gross vehicle orbit errors would be required either due to injection errors or orbit determination errors.

For most of the maneuver sequences for the M = 4 mission, the Operations performed will be selected from OP-10, OP-13, OP-14, OP-16 and OP-21.

1.4 Simulation Output

The output for a single simulation run consists of hundreds of pages of print of vehicle parameters defining the mission sequence of events in detail. Of primary concern for this study are the effects of vehicle injection errors, tracking and orbit determination errors, and maneuver execution errors on the mission maneuver sequence and conditions at the M-1 Spacecraft apogee after the NSR maneuver has been completed, since these conditions will be used in terminal rendezvous guidance studies to be performed by McDonnell and MSC/MPAD. Therefore, data considered to be pertinent to this type of analysis has been extracted from the print-outs of the simulation runs and compiled in the data tables presented in Section 3.0. In addition, the complete SOPFMT output is presented in Section 4.0.

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2.0 ANALYSIS RESULTS

This Section presents the results obtained from an analysis of the nominal and 15 noisy mission simulation runs obtained for the M = 4 rendezvous mission. Four primary mission areas were considered in the analysis:

(1) Mission maneuver sequence and effects of injection errors on the sequence;
(2) NSR maneuver conditions at third Spacecraft apogee;
(3) Maneuver velocity requirements and execution errors;
(4) Tracking and command network capabilities and constraints.

A brief review of the nominal mission plan, Reference 7, is presented prior to presentation of the analysis results. Conclusions and recommendations regarding the M = 4 mission are presented after the analysis results.

2.1 Nominal Mission Plan for M = 4

The nominal mission plan for the M = 4 rendezvous mission is presented in detail in Reference 7. Briefly, the Agena is launched into a 161 n. mi. circular orbit at an inclination of 28.87 degrees. Approximately 95 minutes later, the Spacecraft is launched into an 87-146 n. mi. elliptic orbit with the injection phase angle being 16.57 degrees and the catch-up rate 6.64 degrees per Spacecraft orbit. The inclination of the Spacecraft orbit is 28.87 degrees and the ascending node is located such that the differential nodal regression will make the orbit planes co-planar at rendezvous. The nominal midcourse maneuver sequence is:

(1) A Spacecraft period adjustment (NCI) at the second Spacecraft apogee reducing the catch-up rate to obtain a 1.9 degree phase angle at third Spacecraft apogee.
(2) A Spacecraft co-elliptic maneuver (NSR) at third Spacecraft apogee aligning the vehicle apsis lines with Spacecraft apogee and perigee respectively 15 n.mi. below the Agena apogee and perigee.

Final rendezvous is then accomplished approximately one orbit later (M = 4) using the on-board terminal rendezvous guidance system.

Provision is made in the nominal midcourse maneuver sequence for performing a height adjustment maneuver (NH) at the perigee following first Spacecraft apogee (M = 1.5) and a plane change maneuver (NPC) at the node closer to the Spacecraft perigee after second Spacecraft apogee, if these maneuvers are required.

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2.1.1 Implementation of M = 4 Maneuver Sequence in the Gemini Simulation

The capability of performing the above described M = 4 nominal mission maneuver sequence and any possible combinations of non-nominal maneuver sequences was implemented in the Gemini Simulation by proper selection of the OCL constants. These constants were selected such that an NCI maneuver (OP-10, 16, or 17) was always performed at M = 2 and the NSR maneuver (OP-21) always performed at M = 3. The following constants were used to control scheduling of the NH maneuver (OP-14) and the NPC maneuver (OP-13 or OP-9).

(1) If the height difference between Spacecraft apogee and the Agena radius over the Spacecraft apogee (ΔH) was not within 3,000 feet of the nominal 15 n.mi. difference at the time of first Spacecraft apogee, an NH maneuver was performed at M = 1.5.

(2) If the out-of-plane angle at rendezvous (δ_t) was less than 0.05 degrees, no NPC maneuver was performed. For $0.05 < \delta_t \leq 0.55$ degrees, the Spacecraft was used for the NPC maneuver at the specified time. For $\delta_t > 0.55$ degrees, the Agena was used for the NPC maneuver.

(3) An NH maneuver could also be performed at M = 2.5 if no NPC maneuver was required and if ΔH was not within 6,000 feet of the nominal 15 n. mi. difference at M = 2. This maneuver was not obtained in any of the simulation runs.

It should be remembered that the Gemini Simulation runs do not include any terminal rendezvous maneuvers and the simulation run is terminated one Spacecraft mean period following the NSR maneuver.

2.2 Mission Maneuver Sequence

The primary parameters which determined the maneuver sequences for the nominal and 15 noise mission simulation runs of this study were the Agena and Spacecraft injection errors and the OCL constants controlling the NH and NPC maneuvers. One other major factor was also key in determining the maneuver sequence; the nominal Spacecraft injection conditions used in each of the 15 noise runs were the same (prior to addition of the injection errors). Thus, the Spacecraft injection conditions were not re-targeted to the actual Agena orbit for each run and the full effects of the Agena injection errors were propagated to the midcourse maneuvers. If the Spacecraft injection conditions had been re-targeted, the NH and NPC maneuver requirements in particular would have been reduced.

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2.2.1 Vehicle Injection Errors

Tables 9.0 and 10.0 of Section 3.0 present the Agena and Spacecraft nominal and noisy injection conditions used in the simulation runs for this study. Table 11.0 of Section 3.0 presents a number of relative orbital parameters after noise has been added to the Spacecraft injection conditions. Table 1.0 lists the maximum, minimum, and nominal values of ΔH, δ_t, phase angle (θ_R) and catch-up rate ($\dot{\theta}_R$) obtained from the simulation runs after injection errors had been added to the Spacecraft. These parameters are presented since they define, together with the allowable mission time and desired values of these parameters at the NSR maneuver time, the maneuvers which will be required during the mission.

TABLE 1.0 Range of Selected Relative Parameters at Spacecraft Injection

	ΔH (ft)	δ_t (deg)	θ_R (deg)	$\dot{\theta}_R$ (deg/ S/C orbit)
Minimum	28,921	0.030	16.225	5.653
Nominal	91,145	0.017	16.56	6.629
Maximum	135,201	0.558	16.82	7.110

2.2.2 Mission Sequence Summary

The maneuver sequences used for the nominal and 15 noise runs are presented in Section 3.0, Table 12.0 . A summary of the number of simulation runs using the same maneuver sequence is presented below in Table 2.0.

TABLE 2.0 Summary of Mission Maneuver Sequences

No. of Runs Using Sequence	Maneuver Sequence			
	M = 1.5 (NH)	M = 2.0 (NCI)	M = 2.5 (NPC)	M = 3.0 (NSR)
11	14	10	13	21
2	--	10	13	21
1	14	16	--	21
1	14	10	9	21
Nominal	--	16	--	21

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As can be seen from Table 2.0, 13 of the noise runs required a Spacecraft apogee height adjustment maneuver (NH) at M = 1.5. This maneuver is to be expected on the basis of Spacecraft velocity injection errors alone (Reference 8) and the 3,000 ft. allowable ΔH error used in the simulation. Similarly, a plane change maneuver by the Spacecraft (NPC) is also to be expected due to the 0.05 degree tolerance limit and expected Spacecraft out-of-plane position and azimuth errors at injection. The run requiring an Agena plane change was somewhat surprising, but not totally unexpected when consideration is given to Agena azimuth injection errors (Reference 9) and no re-targeting of the Spacecraft injection conditions.

2.3 NSR Maneuver Conditions

The primary objective of all midcourse maneuvers, including the NSR maneuver, is to obtain the following desired conditions at completion of the NSR maneuver:

(1) Phase angle of 1.9 degrees;

(2) Coincident vehicle apsis lines with the Spacecraft apogee and perigee 15 n. mi. below the Agena apogee and perigee altitudes;

(3) The Spacecraft orbit plane regressing into the Agena orbit plane such that the wedge angle is zero at fourth Spacecraft apogee.

Table 16.0 of Section 3.0 presents values of the above parameters, except out-of-plane angle, for the nominal and 15 noise runs. The values of out-of-plane angle after the NSR maneuver are listed in the SOPFMT, Section 4.0. Table 3.0 below lists the maximum, minimum, and nominal values obtained from the simulation runs for the following parameters:

θ_P - Spacecraft pitch angle used for the NSR maneuver referenced from local horizontal at burn initiation, downward is positive (degrees)

θ_R - Phase angle following NSR (degrees)

$\dot{\theta}_R$ - Catch-up rate per Spacecraft orbit following NSR maneuver (degrees per Spacecraft orbit)

Δh_a - Height difference between Agena apogee altitude and Spacecraft apogee altitude (n. mi.)

Δh_p - Height difference between Agena perigee altitude and Spacecraft perigee altitude (n. mi.)

$\Delta\omega$ - Angle between the Spacecraft and Agena apsis lines (degrees)

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TABLE 3.0 Orbital Parameters After NSR Maneuver

	θ_P	θ_R	$\dot{\theta}_R$	Δh_a	Δh_p	$\Delta\omega$
Minimum	-33.8	1.81	2.10	14.0	14.2	0.98
Nominal	4.3	1.89	2.31	15.5	15.5	3.88
Maximum	55.9	1.90	2.49	16.7	16.7	8.30

The maximum values of Δh_a, Δh_p, and the minimum value of θ_R were all obtained from the run which required the Agena plane change. The in-plane velocity error obtained while performing the plane change altered the Agena period and radius over Spacecraft apogee sufficiently to cause the resulting values of Δh_a, Δh_p, and θ_R. It should be remembered that the plane change is performed between M = 2 and M = 3, after the last catch-up rate adjustment and after any height adjustment maneuver. Therefore, any in-plane errors obtained from the NPC maneuver cannot be corrected prior to the NSR maneuver. For the runs where the Spacecraft performed the NPC maneuver, the maximum values of Δh_a and Δh_p were 15.8 and 15.9 n. mi. respectively, and the minimum phase angle 1.822 degrees.

The pitch angle used for the NSR maneuver will be primarily dependent on the change in Spacecraft flight path angle required to make the orbits co-elliptic. The required change in flight path angle is dependent on the ellipticity of the Agena orbit and of the Spacecraft orbit prior to the NSR maneuver. From Table 3.0 it can be seen that a large range of pitch angles was obtained from the 15 runs, the range being from 55.9 degrees pitch down to 33.8 degrees pitch up. The average required pitch angle was 22.0 degrees down.

The accuracy to which the vehicles' line of apsides can be aligned has been found to be a function of the required pitch angle magnitude. In general, better apsides alignment is obtained with larger required pitch angles, with the alignment capability decreasing for required pitch angles less than 5.0 degrees. The maximum value of $\Delta\omega$ presented in Table 3.0 was obtained using a pitch angle of 2.55 degrees, which included a -0.6 degree pitch angle error. All other noise runs required pitch angles of $\pm$ 10 degrees or more, and the resulting values of $\Delta\omega$ were all less than 4 degrees.

2.3.1 SOPFMT Results

The Statistical Output Format (SOPFMT) program results presented in Section 4.0 include detailed vehicle relative co-ordinate information immediately after

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the NSR maneuver. The mean up, downrange, and crossrange distances, computed in a Differential Cylindrical Co-ordinate System, after the NSR maneuver and the sample standard deviation are presented below:

Up	-	92,156 feet	(3082 ft)
Down	-	715,060 feet	(9,908 ft)
Cross	-	1,042 feet	(2,178 ft)

These values indicate that for the M = 4 rendezvous mission, the desired 15 n. mi. height difference should be obtained within ± 1.5 n. mi. and the out-of-plane distance should not exceed approximately 1 n. mi. after the NSR maneuver. A variation of up to 5 n. mi. in relative downrange position is to be expected.

2.4 Maneuver Velocity Requirements and Execution Errors

2.4.1 Velocity Requirements

The mission midcourse maneuver velocity requirements are primarily dependent on the relative vehicle positions obtained at injection of the Spacecraft. Thus, Agena and Spacecraft injection errors will have a strong effect on maneuver velocity requirements, especially since the Spacecraft injection conditions were not re-targeted to the perturbed Agena orbit. The primary effect of these errors, as noted previously, will be in the velocity required for NH and NPC maneuvers. The combined velocity requirements for the NCI and NSR maneuvers will not be seriously affected by injection errors, with additional velocity requirements being dependent on the amount of radial velocity required in the NSR maneuver to rotate the Spacecraft line of apsides.

Table 15.0 of Section 3.0 presents the values of velocity increments used for each maneuver for the nominal and 15 noise runs. Table 4.0 presents the maximum, minimum, and nominal values of velocity increments required for each of the possible midcourse maneuvers in the M = 4 mission sequence. The total velocity requirements are based on individual run results and are not the sums of the maximum and minimum values.

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TABLE 4.0 Summary of Midcourse Maneuver Velocity Requirements

Maneuver	Maximum	Nominal	Minimum
NH	17.81	----	1.84
NCI	73.05	49.0	11.31
NPC	188.92 (248.55 Agena)	----	27.32
NSR	93.95	56.0	42.89
TOTAL	311.84	105.0	108.04

It should be noted that the maximum ΔH maneuver ΔV requirement and the minimum NCI maneuver ΔV requirement occurred on the same run. For this run, the Spacecraft apogee was high, thus causing a low catch-up rate. If the NH maneuver had been delayed until M = 2.5, the Spacecraft could not have caught up to the 1.9 degree apogee phase angle at M = 3.0. This run points out the necessity for performing the NH maneuver as soon as possible after Spacecraft injection, especially for short duration missions.

The large range in NPC maneuver ΔV requirements is primarily due to Agena azimuth injection dispersions and not re-targeting the Spacecraft injection conditions. The NH maneuver ΔV requirements are due to a combination of Spacecraft injection velocity dispersions and Agena injection dispersions.

2.4.2 Maneuver Execution Times

Table 5.0 presents the variation in maneuver execution times obtained from the 15 noise runs. The exact maneuver times for each run are presented in Table 19.0 of Section 3.0, together with the attitude angle and rate errors used for each maneuver.

TABLE 5.0 Maneuver Execution Times

Maneuver	Min. Time (sec)	Max. Time (sec)	Δt (sec)
NH	11622.9	11831.3	208.4
NCI	14260.3	14480.7	220.4
NPC	15865.0	17724.8	1859.8
NSR	19533.0	19848.2	315.2

Time is referenced from Agena liftoff.

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Since the NH and NCI maneuvers are performed at Spacecraft apsis points, and are the first maneuvers performed, their execution time will be strongly dependent on the injection true anomaly of the Spacecraft. For the minimum time run the true anomaly at injection was 8.99 degrees and for the maximum time run it was 354.50 degrees. The time required by the Spacecraft to move through this range of true anomalies is 217 seconds, approximately the time difference noted for the NH and NCI maneuvers in Table 5.0.

Although the NSR maneuver is also performed at an apsis point, the time difference will not only include the injection true anomaly effects but also the differences in magnitudes of the NH, NCI, and NPC maneuvers. The primary effect, however, is still the injection true anomaly difference.

The NPC maneuver times show the greatest variation in execution time, as is to be expected. Since the relative node location is strongly dependent on knowledge of the Agena's orbit orientation to the equator and Spacecraft azimuth injection errors, re-targeting the Spacecraft to the actual Agena orbit should reduce this time spread. For most of the simulation runs the NPC maneuver was performed between M = 2.25 and M = 2.50, with the extremes being near M = 2.25 and M = 2.75.

2.4.3 Maneuver Execution Errors

The maneuver execution errors obtained from the 15 noise runs did not appreciably effect the conditions obtained after the NSR maneuver, except for the run requiring an Agena plane change. For this case the desired ΔH value was exceeded by almost 1 n. mi. more than for the Spacecraft only maneuver cases. The Spacecraft execution errors will not seriously effect a short duration mission, since the errors are small and are not propagated for an appreciable length of time. The largest velocity error obtained for any of the in-plane maneuvers was 0.7 feet/sec., including the round-off. The maximum in-plane ΔV error to be expected from a Spacecraft plane change is approximately 1.8 feet/sec., based on a plane change maneuver of 240 feet/sec. and a yaw angle error of 0.415 degrees. The ΔV errors for the maneuvers of each noise run can be obtained from Tables 14.0 and 15.0 of Section 3.0, while the vehicle attitude angle and rate errors for each maneuver of each noise run are presented in Table 19.0 of the same Section.

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2.5 Tracking and Command Network Analysis

In the Gemini Closed-Loop Systems Simulation, the complete Gemini Tracking and Command Network (Reference 10) is simulated, exclusive of ship locations. The orbit determination model used in the Simulation is the TRW/STL General Tracking Program. This program accepts noisy radar measurement data from the tracking stations and performs an orbit determination for each vehicle. The vehicles' orbit fit is performed prior to each Spacecraft apogee, and prior to each maneuver that is not executed at apogee. These vehicle state vectors are then used as the basis for OCL decisions as to what maneuvers are required and for all maneuver computations.

For the Study 2 error analysis mission simulation runs, it was assumed that all radar measurements taken up to 5 minutes before a maneuver could be used in the orbit fit to determine the vehicles' state vectors for use in maneuver computations. Since these runs have been made, it has been established that a much larger time interval than 5 minutes should be allowed for orbit determination, maneuver decisions, and command generation and transmittal prior to a maneuver (Reference 11). Table 6.0 presents the time requirements specified for determination of vehicle maneuvers:

(1) Maneuver Preparation Time (t_p) - Time interval from vehicle receiving maneuver command to initiation of maneuver.

(2) Command Transmission Time - Time required by a command station to transmit the required maneuver commands to the maneuvering vehicle (t_c).

(3) RTCC Computation Time - Time required by the RTCC to receive tracking information, perform an orbit determination, determine the required maneuver commands, encode the commands, transmit the commands to the command site, and verify that the proper commands were received by the command site (t_{RTCC}).

The numbers presented in Table 6.0 imply that any tracking information received less than approximately 30 minutes prior to a desired maneuver time cannot be used for determination of that maneuver. Therefore, care must be taken in interpreting the orbit determination errors presented in Tables 17.0 and 18.0 of Section 3.0. These tables present the errors obtained from the orbit determination for each vehicle at each OCL maneuver decision time, which was 5 minutes prior to the scheduled maneuver.

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TABLE 6.0 Maneuver Determination, Transmission, and Preparation Time Requirements

Function	Spacecraft		Agena
	DCS	Voice	
t_p	5 min.	5 min.	5 min.
t_c	4 min.	3 min.	10 min.
(Agena requires two Command Stations of 5 min. each)	(0° to 0° E)	(0° to 0° E)	(0° to 0° E)
t_{RTCC}	25 min.	20 min.	25 min.
Total Maneuver Preparation Time	34 min.	28 min.	40 min.

The errors noted at the OCL decision times for the NH maneuver, NCI maneuver, and NSR maneuver will be representative of the errors to be expected from the orbit fit with the 30-minute preparation time requirement. The errors 5 minutes prior to the maneuver will then be dependent on the accuracy of the ephemeris prediction program used to generate the vehicles' orbits to that point, but these errors should not increase greatly over the orbit determination errors. The orbit determination errors noted at the OCL decision time for the NPC maneuver, however, are probably optimistic for most of the runs. Since the plane change maneuver usually occurs within less than half an orbit after the NCI maneuver, the 30-minute preparation time requirement severely limits the amount of tracking data which can be used for determination of this maneuver. The errors noted in Table 17.0 for the Spacecraft on runs 1, 4, 9, 12, and 14 at the NPC maneuver decision time are more representative of the magnitude of errors to be expected with the 30-minute time requirement. Even with these errors, however, the maneuver was performed without compromising the capability to satisfactorily meet the desired NSR conditions.

Table 7.0 presents a summary of the M = 4 mission tracking and command considerations considering the maneuver preparation times listed in Table 6.0.

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For each maneuver, Table 7.0 presents the following information:

(1) Type of maneuver;

(2) Orbit number of maneuver;

(3) Geographic location of maneuver;

(4) Command station required for transmitting command to maneuvering vehicle;

(5) Most recent tracking station from which information could be used in determining the specified maneuver, according to the ground rules in Table 6.0;

(6) Time interval between receiving the most recent tracking data and the maneuver execution;

(7) Intervening maneuvers between the specified maneuver determination time and the specified maneuver execution.

From Table 7.0 it can be seen that with the present Tracking and Command Network (exclusive of ships), and the maneuver preparation time requirements of Table 6.0, the Spacecraft NPC maneuver must be determined prior to the NCI maneuver with no information available for updating the maneuver requirements after the NCI maneuver. The situation is worse when the Agena is required to perform the NPC maneuver. The most recent tracking data used in the Agena maneuver computations will be from the previous Agena orbit, and the Spacecraft will have performed both a NH maneuver and a NCI maneuver subsequent to the Agena NPC computations. This condition arises primarily due to the requirement for two command stations prior to an Agena maneuver. If one command station is found to be sufficient, the 6,000 sec. time interval will be reduced to 3,517 sec., and only the NCI maneuver would intervene between the Agena NPC maneuver calculations and the maneuver execution.

The possibility also exists that for a Spacecraft plane change maneuver, tracking from Carnarvon following the NCI maneuver could be used to update the NPC maneuver if a voice command ship could be stationed near Hawaii. However, this possibility requires a more detailed study of the expected maneuver determination accuracy using single station pass tracking data compared with the maneuver accuracy determined prior to the NCI maneuver, assuming a nominal NCI maneuver, before a definite requirement for a ship at this location can be established.

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TABLE 7.0 Tracking and Command Network Availability, M = 4

Maneuver	M Number	Approx. Location of Maneuver	Vehicle Performing Maneuver	Type of Command Transmission	Command Stations Used	Last Tracking Stations Used For Maneuver Computations	Approx. Time Between Tracking Information and Performance of Maneuver (sec)	Intervening Maneuvers Between Specified Maneuver Computations and Maneuver Execution
NH	1.5	Gulf of Mexico	S/C	Digital	Hawaii	Carnarvon	2600	None
				Voice	Guyamas Texas	Carnarvon	2300	None
NCI	2.0	West Indian Ocean	S/C	Digital	Antigua	Hawaii	3900	NH
				Voice	Tananerive	Antigua	2000	None
NPC	≈2.35	Hawaii	S/C	Digital	Carnarvon	Ascension	3300	NCI
				Voice	Carnarvon	Pretoria	2900	NCI
			Agena	Digital	Antigua & Carnarvon	Hawaii	6000	NH, NCI
NSR	3.0	West Indian Ocean	S/C	Digital	Antigua	Hawaii	3600	NPC
				Voice	Tananerive & Ascension	Cape Kennedy Grand Bahama	2300	None

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The data of Table 7.0 also point out the advantage of using voice commands for the NCI and NSR maneuvers. If the voice command stations are not available, for these maneuvers, then no capability exists to update the maneuver requirements after the intervening maneuvers have been performed. Lack of this updating capability could well affect the performance of the NSR maneuver, with a resultant degradation in obtaining the desired initial conditions for the terminal rendezvous maneuvers.

2.5.1 Classification of Tracking Accuracy

Table 8.0 presents a set of tracking accuracy classifications and associated orbit plane tracking errors which can be used to evaluate the orbit determination errors presented in Tables 17.0 and 18.0 of Section 3.0. Using the data from these tables, the following evaluation of the tracking information available for determination of the M = 4 mission maneuvers can be made:

NH - excellent;
NCI - excellent;
NPC - good (with a good ephemeris prediction program);
NSR - excellent.

TABLE 8.0 Orbit Determination Error Classification

Classification	Δu (ft)	Δv (ft)	Δw (ft)	$\Delta \dot{u}$ (fps)	$\Delta \dot{v}$ (fps)	$\Delta \dot{w}$ (fps)
Excellent	< 250	< 1000	< 250	< 2	< 0.2	< 0.2
Good	< 2500	<10000	< 2500	< 20	< 2	< 2
Fair	< 5000	<20000	< 5000	< 40	< 4	< 4
Poor	> 5000	>20000	> 5000	> 40	> 4	> 4

The u coordinate axis is upward along the local vertical.
The v coordinate axis is forward in the downrange direction.
The w coordinate axis is to the left in the crossrange direction.
The large values for $\Delta \dot{u}$ are the result of a high correlation (due to the geometry of the coordinate system) between the u and v components. The inertial velocity error is approximately the root sum square of $\Delta \dot{v}$ and $\Delta \dot{w}$.

2.6 Conclusions

Analysis of the M = 4 error analysis simulation runs results has led to the following conclusions regarding the M = 4 Gemini rendezvous mission:

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(1) The expected maneuver sequence, whether or not the Spacecraft is re-targeted to Agena injection conditions, is:

NH	$M = 1.5$
NCI	$M = 2.0$
NPC	$M \cong 2.5$
NSR	$M = 3.0$

(2) The total Spacecraft midcourse velocity requirements in excess of the nominal mission velocity requirements will be primarily determined by the magnitude of the NPC maneuver and the radial velocity component required for the NSR maneuver. The total midcourse velocity required from the Spacecraft will be greater than 105 feet/sec. but less than 380 feet/sec.

(3) Spacecraft maneuver execution requirements should not influence total mission midcourse velocity requirements or adversely effect the capability to obtain the desired relative conditions after the NSR maneuver.

(4) The pitch angle required for the NSR maneuver can have a wide variation in magnitude, with either positive or negative pitch required depending on the Agena and Spacecraft orbital parameters at the maneuver time.

(5) Following the NSR maneuver, the Agena and Spacecraft lines of apsides should be aligned to within 4 degrees, except when the Spacecraft pitch angle for the NSR maneuver is less than 5.0 degrees. For these cases the apsides should be aligned to within 10 degrees.

(6) The height difference between Spacecraft and Agena apogee and perigee should be within 1.5 n. mi. of the desired 15 n. mi. difference following the NSR maneuver, if no Agena plane change is required. When an Agena NPC maneuver is required, the height difference error should be less than 3 n. mi.

(7) The Phase angle following the NSR maneuver should be within 0.1 degrees of the desired 1.9 degree value.

(8) The out-of-plane angle following the NSR maneuver should be less than 0.015 degrees when an NPC maneuver is performed.

(9) All in-plane maneuvers should be performed within 6 minutes of the expected nominal maneuver execution time. Changes in in-plane maneuver times are primarily due to injection dispersions in Spacecraft true anomaly.

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(10) All in-plane maneuvers by the Spacecraft can be based on good tracking information after a prior maneuver if the voice command stations noted in Table 7.0 are available.

(11) All plane change maneuvers, either by the Spacecraft or by the Agena, will be determined on the basis of tracking information prior to the NCI maneuver and will be performed without updated tracking information after the NCI maneuver. On the basis of the simulation results it does not appear that this will be a serious problem.

2.7 Recommendations

The following recommendations are made regarding the M = 4 rendezvous mission on the basis of the error analysis study results.

(1) The nominal mission sequence of events should be based on the following maneuver sequence:

NH M = 1.5
NCI M = 2.0
NPC M ≈ 2.5
NSR M = 3.0

(2) A fuel allowance of 380 feet/sec. should be provided for Spacecraft midcourse maneuvers. This allowance includes 240 feet/sec. for the NPC maneuver.

(3) If the Spacecraft injection conditions are not re-targeted to the actual Agena orbit prior to Spacecraft launch, the mission maneuver sequence should include the possibility of performing the NPC maneuver with the Agena.

(4) The voice command stations noted in Table 7.0 should be used to command the NCI and NSR maneuvers.

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3.0 DATA TABLES

This Section contains eleven data tables presenting what is considered to be a concise compilation of pertinent mission data from the 16 simulation runs. Since each simulation run contains over 10,000 lines of print defining each step of the mission in detail, presentation of the complete print-out for all runs is impractical. Should more information about the mission be desired, print-outs of each run are available both at STL and at the Rendezvous Analysis Branch, Mission Planning and Analysis Division of MSC.

3.1 Agena and Spacecraft Injection Data

Table 9.0 presents the nominal Agena and Spacecraft injection data specified for the M = 4 mission by MSC (Reference 6). These data define the initial vehicle orbits for the nominal run, and also the initial orbits to which injection errors are added to obtain the "run nominal" orbits for the noise runs. The following nomenclature is used in the table:

t_{inj}	-	Time of vehicle injection measured from Agena liftoff (sec).
t_L	-	Time of Spacecraft liftoff measured from Agena liftoff (sec).
x,y,z	-	Components of vehicle position in an earth centered, right handed, inertial coordinate system (ECI). The system is oriented at t = 0 (Agena liftoff) with the x-z plane through zero longitude (Greenwich), and the x-y plane containing the equator. The z-axis passes through the North Pole (feet).
$\dot{x},\dot{y},\dot{z}$	-	Components of vehicle velocity in the ECI coordinate system (feet/sec).
W	-	Vehicle weight at injection (lbs).

3.2 Agena Orbit Parameters at t_{inj} + 11.0 Seconds

Table 10.0 presents the Agena orbital parameters after injection errors have been added to the nominal parameter values at 11 seconds after Agena injection. The manner in which injection errors are considered for the Agena is discussed in Reference 9 . These values define the "run nominal" Agena orbit for each of the 15 noise runs. The following parameters are presented in Table 10.0:

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R	-	Radius (feet)
ϕ	-	Geocentric latitude (deg)
λ	-	Longitude-Measured positive East from Greenwich (deg)
V_I	-	Inertial velocity (feet/sec)
A_I	-	Azimuth of inertial velocity vector-measured positive East of North (deg)
β	-	Flight path angle-measured positive down from the local vertical (deg)
T	-	Osculating value of period (min)
e	-	Osculating value of eccentricity
i	-	Osculating value of inclination (deg)

3.3 Spacecraft Orbit Parameters at 380 Seconds After Liftoff

Table 11.0 presents the Spacecraft orbital parameters after injection errors have been added to the nominal parameter values at 380 seconds after Spacecraft liftoff. The same parameters are presented in Table 11.0 for the Spacecraft as in Table 10.0 for the Agena.

3.4 Relative and Mean Parameters at 380 Seconds After Spacecraft Liftoff

Table 12.0 presents vehicle relative and mean parameters after injection errors have been added to the Spacecraft orbital parameters. The values in Table 12.0 define the phase angle, height difference, and out-of-plane angle relationships at initiation of the mission, together with other selected parameters. It should be noted that the value of height difference presented in this table is the value obtained from integration of the vehicles' orbits to the Spacecraft apogee position, and not the analytically computed value at the indicated time. The following parameters are presented in Table 12.0.

θ_R	-	Present value of in-plane phase angle-measured positive from the Spacecraft to the Agena (deg)
θ_{R_a}	-	Value of in-plane phase angle at next Spacecraft apogee (deg)
$\dot{\theta}_R$	-	Present value of in-plane catch-up rate (deg/ S/C orbit)
$\bar{\delta}$	-	Present value of mean out-of-plane angle (also called wedge angle, relative inclination) (deg)
$\bar{\delta}_t$	-	Value of mean out-of-plane angle at rendezvous - includes effects of differential nodal regression (deg)

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ΔH - Difference between Agena radius over the Spacecraft apogee and the Spacecraft apogee radius - height difference (feet)

Ω_{SA} - Central angle from the Spacecraft to the ascending node of the Agena with respect to the orbit plane of the Spacecraft (deg)

$\overline{T}_A$ - Mean period of the Agena (sec)

$\overline{T}_S$ - Mean period of the Spacecraft (sec)

3.5 Mission Maneuver Sequences

Table 13.0 presents the maneuver sequences used for each of the mission simulation runs. The maneuver sequence for each run is defined by specifying the OCL Operation Number defining the type of maneuver and the orbit number (in parentheses) during which the maneuver was performed. The correlation between Operation Number and type of maneuver is that specified in Section 1.0.

3.6 Commanded Velocity Increments

Table 14.0 presents the exact required velocity increments for each maneuver of the mission sequence for the 16 simulation runs. These values are obtained from the powered flight iterations performed for each maneuver. The velocity increment which is used as the commanded ΔV for the actual performance of the maneuver in the mission simulation is the value from Table 14.0 rounded to the nearest foot/second. This round-off is done to simulate the granularity to which the astronaut can read his velocity meter. The number in parentheses after each value of ΔV defines the Operation Number for the particular ΔV value. The values of ΔV are presented in Table 14.0 in the same maneuver sequence used in Table 13.0. The following nomenclature is used:

Commanded ΔV - Exact velocity increment required for the maneuver. Obtained from powered flight iteration using noisy position and velocity data with no maneuver execution errors (feet/sec).

$\Delta V_{T_{MC}}$ - Total exact velocity required for all Spacecraft mid-course maneuvers. This value does not include the ΔV used for Spacecraft separation from the Gemini Launch Vehicle or terminal rendezvous maneuver requirements (feet/sec).

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3.7 Velocity Increments Used for Maneuver Sequences

Table 15.0 presents the actual velocity increments used for each maneuver of the mission sequence for the 16 simulation runs. These values will differ from the rounded-off commanded values due to the maneuver execution errors. The number in parentheses after each value of ΔV defines the Operation Number for the particular ΔV value. The values of ΔV are presented in Table 15.0 in the same maneuver sequence as used in Tables 13.0 and 14.0. The following nomenclature is used:

ΔV Used - Actual velocity increment used for the maneuver. Obtained from powered flight burn using true position and velocity data with maneuver execution errors (feet/sec).

$\Delta V_{T_{MC}}$ - Total actual velocity used for all Spacecraft mid-course maneuvers. This value does not include the ΔV used for Spacecraft separation from the Gemini Launch Vehicle or terminal rendezvous maneuver requirements (feet/sec).

3.8 Agena and Spacecraft Orbital Parameters After NSR Maneuver

Table 16.0 presents selected Agena and Spacecraft parameters immediately after the Spacecraft performs the NSR maneuver. The purpose of the NSR maneuver is to place the Agena and Spacecraft in co-elliptic orbits (arguments of perigee equal) with apogee and perigee heights of the two orbits separated by 15 nautical miles. The data of Table 16.0 are presented to reflect how well the NSR maneuver was performed, and to show how well the desired phase angle at the M-1 Spacecraft apogee was obtained ($\theta_R = 1.9°$ for $M = 4$). In addition, the Spacecraft pitch angle used for the NSR maneuver and the catch-up rate after the NSR maneuver are also presented. The following nomenclature is used in Table 16.0:

θ_p - Value of Spacecraft pitch attitude used for the NSR maneuver - measured positive down from the local horizontal (deg)

θ_R - Value of in-plane phase angle after NSR maneuver (deg)

$\dot{\theta}_R$ - Value of catch-up rate after NSR maneuver (deg/ S/C orbit)

h_{a_A} - Osculating value of Agena apogee altitude after NSR maneuver (Nautical Miles)

h_{a_S} - Osculating value of Spacecraft apogee altitude after NSR maneuver (Nautical Miles)

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h_{p_A} - Osculating value of Agena perigee altitude after NSR maneuver (Nautical Miles)

h_{p_S} - Osculating value of Spacecraft perigee altitude after NSR maneuver (Nautical Miles)

ω_A - Osculating value of Agena argument of perigee after NSR maneuver (deg)

ω_S - Osculating value of Spacecraft argument of perigee after NSR maneuver (deg)

3.9 Spacecraft Orbit Determination Errors, Orbit Plane Coordinate System

Table 17.0 presents the errors in Spacecraft position and velocity obtained from the orbit determination at each OCL decision time for the 15 noisy mission simulation runs. These errors are presented in the vehicle centered, orbit plane coordinate system ($\hat{u}$, $\hat{v}$, $\hat{w}$) where

$\hat{u}$ - unit vector in direction of vehicle's radius vector;

$\hat{w}$ - unit vector in direction of angular momentum vector;

$\hat{v} = \hat{w} \times \hat{u}$ - horizontal unit vector in direction of vehicle's motion.

The position and velocity errors are obtained by subtracting the vehicle state vector determined by the orbit fit from the true vehicle state vector.

In the OCL Decision Sequencer (DS) and Guidance Decision and Command Computations (GD & CC), maneuver decisions are based on the vehicle state vectors obtained from the orbit determination. In order to identify the orbit errors at these decision times, a D is used to indicate DS time and a G to indicate GD & CC time. In Table 17.0 these letters are placed in parentheses immediately after the value of time at which the data are being used (column one).

The second column of Table 17.0 lists the number of observation points used in the orbit determination. Two points should be made clear concerning these data:

(1) The actual number of observations that would be obtained in real time is five times the number listed in column two. The number of observations listed in column two is based on a data rate of one observation every 50 seconds, which is the integration step size used in the simulation. In real time the data rate will be one observation every ten seconds. In the simulation, the radar measurement sigmas have been reduced by the square root of five to account for the reduced data rate.

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(2) No observations will be listed for the following entry times to the OCL:

(a) The first DS time (t = 6425), which is actually a dummy entry and is used only to obtain an estimate of the time of first Spacecraft apogee. The position and velocity errors at this time are obtained by noising the vehicle's true position and velocity data by means of an input tracking covariance matrix, and are not the result of an orbit determination for either vehicle.

(b) GD & CC time equal to DS time.

(c) When the GD & CC time is within 30 minutes of the DS time. For this case, both the true and noisy vehicle state vectors are integrated from the DS time to the GD & CC time and the difference then obtained.

In Table 17.0 the following data are presented:

T(sec)	-	Time at which OCL decisions are being made using orbit fit position and velocity data-measured from Agena liftoff (sec)
OBS	-	Number of observation points used in orbit determination
Δu	-	Up (radial) position error due to orbit determination (feet)
Δv	-	Downrange position error due to orbit determination (feet)
Δw	-	Crossrange position error due to orbit determination (feet)
$\Delta \dot{u}$	-	Up velocity error due to orbit determination (feet/sec)
$\Delta \dot{v}$	-	Downrange velocity error due to orbit determination (feet/sec)
$\Delta \dot{w}$	-	Crossrange velocity error due to orbit determination (feet/sec)

3.10 Agena Orbit Determination Errors, Orbit Plane Coordinate System

Table 18.0 presents the same data as Table 17.0, except for the Agena. All comments made for Table 18.0 also apply to this table.

3.11 Attitude Angle and Rate Errors for Maneuver Sequences

Table 19.0 presents the vehicle attitude angle and attitude rate errors used during each of the maneuvers of the mission sequence. The nominal values of these parameters for each maneuver are zero, except for the plane change and NSR maneuvers. For the plane change maneuver there will be a nominal yaw angle and for the NSR maneuver a nominal pitch angle. The rate errors remain constant for all maneuvers

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because the static components of these errors, which are determined at initiation of each run and remain constant for all maneuvers, are much larger than the random components which are determined for each maneuver. The following nomenclature is used in Table 19.0:

T	-	Time of initiation of the maneuver-measured from Agena liftoff (sec)
OP	-	Operation number identifying maneuver performed
$\Delta\alpha_p$	-	Pitch angle attitude error at initiation of burn (deg)
$\Delta\alpha_y$	-	Yaw angle attitude error at initiation of burn (deg)
$\Delta\alpha_r$	-	Roll angle attitude error at initiation of burn (deg)
$\Delta\omega_p$	-	Pitch rate error at initiation of burn (deg)
$\Delta\omega_y$	-	Yaw rate error at initiation of burn (deg)
$\Delta\omega_r$	-	Roll rate error at initiation of burn (deg)

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TABLE 9.0 Vehicle Initial Conditions For M = 4

Agena

t_{inj} = 543.9745788 sec.	W = 7000 lbs.
x = 10181744.25	$\dot{x}$ = 21930.65649
y = 16300970.87	$\dot{y}$ = 12646.63415
z = 10472788.50	$\dot{z}$ = 1634.741592

Spacecraft

t_L = 6045 sec.	W = 7555 lbs.
t_{inj} = 6420.657226 sec.	
x = 14087872.0	$\dot{x}$ = 18799.406
y = 12990022.0	$\dot{y}$ = 16964.57397
z = 9612558.0	$\dot{z}$ = 4620.336975

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TABLE 10.0 Agena Orbit Parameters at t_{inj} + 11.0 Seconds (M = 4)

Run	R(ft)	ϕ(deg)	λ(deg)	V_I(fps)	A_I(deg)	β(deg)	T(min)	e	i(deg)
Nom.	21,887,652	28.530	-59.500	25368.57	94.607	89.998	90.474	0.000681	28.869
1	21,889,296	28.527	-59.448	25367.61	94.640	89.964	90.484	0.000925	28.871
2	21,890,329	28.601	-59.804	25366.15	94.091	89.966	90.481	0.000849	28.868
3	21,891,338	28.623	-59.554	25362.97	94.048	89.956	90.460	0.000867	28.884
4	21,883,123	28.541	-59.600	25374.34	94.481	90.105	90.479	0.002060	28.861
5	21,890,071	28.573	-59.608	25366.22	94.409	89.919	90.479	0.001533	28.573
6	21,884,661	28.469	-59.468	25372.00	94.960	90.083	90.473	0.001663	28.863
7	21,882,289	28.507	-59.427	25372.22	94.778	90.143	90.446	0.002594	28.871
8	21,884,840	28.585	-59.752	25372.17	94.259	90.100	90.477	0.001932	28.874
9	21,886,422	28.544	-59.652	25369.86	94.482	89.995	90.472	0.000731	28.865
10	21,884,114	28.694	-59.311	25375.05	94.571	90.057	90.499	0.001428	28.866
11	21,886,080	28.543	-59.441	25368.89	94.487	90.074	90.458	0.001439	28.864
12	21,886,588	28.520	-59.738	25370.17	94.773	90.062	90.478	0.001327	28.884
13	21,884,128	28.500	-59.519	25372.22	94.670	90.067	90.469	0.001424	28.849
14	21,885,489	28.490	-59.621	25369.36	94.896	90.053	90.455	0.001134	28.873
15	21,891,963	28.536	-59.560	25363.53	94.503	89.869	90.473	0.002344	28.860

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TABLE 11.0 Spacecraft Orbit Parameters at 380 Seconds After Liftoff (M = 4)

Run	R(ft)	ϕ(deg)	λ(deg)	V_I(fps)	A_I(deg)	β(deg)	T(min)	e	i(deg)
Nom.	21,438,533	26.579	-69.195	25740.29	101.735	89.991	88.821	0.009083	28.881
1	21,439,152	26.501	-69.113	25740.29	101.774	89.999	88.829	0.009110	28.825
2	21,438,125	26.530	-69.188	25752.07	101.762	90.055	88.940	0.010031	28.846
3	21,442,431	26.596	-69.104	25749.23	101.774	90.039	88.964	0.009990	28.911
4	21,432,480	26.470	-69.218	25739.84	101.754	90.016	88.740	0.008765	28.789
5	21,448,286	26.717	-69.431	25741.91	101.589	89.913	88.961	0.009785	28.952
6	21,428,097	26.486	-69.112	25754.72	101.786	89.968	88.842	0.009736	28.816
7	21,434,262	26.563	-69.238	25743.94	101.726	90.037	88.806	0.009189	28.863
8	21,442,650	26.598	-69.386	25758.97	101.647	90.014	89.070	0.010743	28.865
9	21,442,421	26.551	-69.196	25724.05	101.730	90.008	88.700	0.007992	28.854
10	21,427,228	26.559	-68.991	25745.37	101.815	90.038	88.733	0.008972	28.893
11	21,435,065	26.576	-69.066	25744.74	101.786	90.002	88.825	0.009267	28.897
12	21,441,822	26.665	-69.198	25731.56	101.715	89.995	88.770	0.008552	28.952
13	21,445,793	26.591	-69.422	25741.80	101.657	89.990	88.928	0.009543	28.862
14	21,441,922	26.671	-69.159	25735.66	101.727	89.972	88.815	0.008889	28.962
15	21,444,272	26.650	-69.044	25732.48	101.786	90.025	88.811	0.008750	28.964

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TABLE 12.0 Relative and Mean Parameters at 380 Seconds After Spacecraft Liftoff (M = 4)

Run	θ_R(deg)	θ_{R_a} (deg)	$\dot{\theta}_R$(°/orbit)	$\bar{\delta}$ (deg)	$\bar{\delta}_t$(deg)	ΔH(ft)	Ω_{SA}(deg)	$\bar{T}_A$(sec)	$\bar{T}_S$(sec)
Nom.	16.560	13.221	6.629	0.01978	0.01978	91,145	324.299	5425.9	5326.0
1	16.466	12.970	6.639	0.05092	0.05976	87,673	51.750	5426.5	5326.4
2	16.225	12.761	6.186	0.40136	0.42733	46,362	136.981	5426.3	5333.1
3	16.492	13.165	6.005	0.53179	0.55823	34,593	143.286	5425.0	5334.6
4	16.487	13.218	6.974	0.15435	0.17777	129,928	108.047	5426.2	5321.1
5	16.650	13.603	6.090	0.09305	0.11343	49,312	183.982	5426.2	5334.4
6	16.534	13.620	6.544	0.31706	0.29099	82,901	331.721	5425.8	5327.2
7	16.820	13.807	6.581	0.13234	0.10561	105,864	330.091	5424.2	5325.0
8	16.524	13.925	5.653	0.22184	0.24817	28,921	135.813	5426.1	5340.9
9	16.429	12.760	7.110	0.04896	0.07402	135,201	111.219	5425.8	5318.6
10	16.467	12.861	7.080	0.10038	0.12628	127,001	149.728	5427.4	5320.6
11	16.583	13.511	6.553	0.12686	0.15291	90,698	150.861	5424.9	5326.2
12	16.376	13.132	6.844	0.34824	0.32249	119,426	312.376	5426.1	5322.9
13	16.794	13.913	6.184	0.05639	0.03049	71,647	320.894	5425.6	5332.4
14	16.537	13.503	6.580	0.43075	0.40482	96,746	311.069	5424.7	5325.6
15	16.346	12.413	6.666	0.10087	0.10676	79,349	227.837	5425.8	5325.4

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TABLE 13.0 Maneuver Sequences (M = 4)

Run	Maneuver Sequence							
Nom.	16 (2)	21 (3)						
1	10 (2)	13 (2)	21 (3)					
2	14 (1)	10 (2)	13 (2)	21 (3)				
3	14 (1)	10 (2)	9 (2)	21 (3)				
4	14 (1)	10 (2)	13 (2)	21 (3)				
5	14 (1)	10 (2)	13 (2)	21 (3)				
6	14 (1)	10 (2)	13 (2)	21 (3)				
7	14 (1)	10 (2)	13 (2)	21 (3)				
8	14 (1)	10 (2)	13 (2)	21 (3)				
9	14 (1)	10 (2)	13 (2)	21 (3)				
10	14 (1)	10 (2)	13 (2)	21 (3)				
11	10 (2)	13 (2)	21 (3)					
12	14 (1)	10 (2)	13 (2)	21 (3)				
13	14 (1)	16 (2)	21 (3)					
14	14 (1)	10 (2)	13 (2)	21 (3)				
15	14 (1)	10 (2)	13 (2)	21 (3)				

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TABLE 14.0 Commanded Velocity Increments for Maneuver Sequences (M = 4)

Run	Commanded ΔV (fps)							$\Delta V_{T_{MC}}$ (fps)
Nom.	48.52 (16)	56.14 (21)						104.87
1	55.18 (10)	27.09 (13)	54.52 (21)					136.79
2	12.29 (14)	56.53 (10)	189.42 (13)	53.58 (21)				311.82
3	15.77 (14)	44.16 (10)	246.41 (9)	62.97 (21)				369.31
4	11.51 (14)	47.23 (10)	78.96 (13)	68.23 (21)				205.93
5	11.34 (14)	30.45 (10)	50.38 (13)	86.18 (21)				178.35
6	2.03 (14)	37.56 (10)	130.61 (13)	74.54 (21)				244.74
7	4.41 (14)	25.42 (10)	47.84 (13)	91.43 (21)				169.10
8	17.88 (14)	11.00 (10)	110.30 (13)	94.05 (21)				233.23
9	13.55 (14)	61.52 (10)	32.06 (13)	42.86 (21)				149.99
10	10.95 (14)	61.98 (10)	55.42 (13)	48.59 (21)				176.94
11	37.86 (10)	67.68 (13)	71.25 (21)					176.79
12	8.53 (14)	47.26 (10)	145.33 (13)	60.35 (21)				261.47
13	5.43 (14)	17.15 (16)	86.50 (21)					109.08
14	1.97 (14)	36.16 (10)	182.04 (13)	69.45 (21)				289.62
15	2.01 (14)	73.11 (10)	47.23 (13)	65.78 (21)				188.13

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TABLE 15.0 Velocity Increments Used for Maneuver Sequences (M = 4)

Run	ΔV Used (fps)							$\Delta V_{T_{MC}}$ (fps)
Nom.	49.00 (16)	56.00 (21)						105.00
1	55.25 (10)	27.32 (13)	54.63 (21)					137.20
2	11.88 (14)	56.99 (10)	188.92 (13)	54.04 (21)				311.84
3	15.94 (14)	44.11 (10)	248.55 (9)	62.85 (21)				371.45
4	11.83 (14)	47.38 (10)	79.22 (13)	68.26 (21)				206.68
5	11.43 (14)	29.94 (10)	50.16 (13)	86.18 (21)				177.71
6	1.84 (14)	38.22 (10)	131.16 (13)	75.13 (21)				246.35
7	4.22 (14)	25.25 (10)	47.90 (13)	90.73 (21)				168.11
8	17.81 (14)	11.31 (10)	109.98 (13)	93.95 (21)				233.05
9	14.07 (14)	62.21 (10)	31.96 (13)	42.89 (21)				151.13
10	11.24 (14)	62.07 (10)	55.17 (13)	49.12 (21)				177.59
11	38.10 (10)	67.99 (13)	71.29 (21)					177.38
12	8.88 (14)	46.59 (10)	145.09 (13)	59.92 (21)				260.47
13	4.80 (14)	17.08 (16)	86.17 (21)					108.04
14	1.91 (14)	35.95 (10)	181.64 (13)	68.95 (21)				288.46
15	2.04 (14)	73.05 (10)	47.10 (13)	65.89 (21)				188.08

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TABLE 16.0 Agena & Spacecraft Orbital Parameters After NSR Maneuver (M = 4)

Run	θ_P(deg)	θ_R(deg)	$\dot{\theta}_R$(°/orbit)	h_{a_A} (ft)	h_{a_S} (ft)	h_{p_A} (ft)	h_{p_S} (ft)	ω_A(deg)	ω_S(deg)
Nom.	4.285	1.894	2.313	167.9	152.4	162.0	146.5	292.457	288.581
1	19.299	1.879	2.212	169.3	154.5	161.2	146.4	324.607	323.113
2	16.639	1.892	2.185	169.9	155.3	161.0	146.3	322.931	319.744
3	19.434	1.811	2.491	170.1	153.4	160.9	144.2	326.742	324.961
4	-33.766	1.885	2.287	171.6	156.4	158.8	143.3	209.736	205.833
5	33.739	1.848	2.262	170.7	155.5	158.9	143.7	340.796	338.686
6	-21.086	1.903	2.238	170.3	155.4	159.4	144.3	217.398	216.413
7	-31.968	1.871	2.352	173.2	157.5	155.6	139.7	210.493	205.334
8	-16.163	1.866	2.344	171.3	155.6	158.9	143.1	212.604	208.781
9	2.553	1.903	2.200	168.0	153.2	162.1	147.3	299.586	291.285
10	-23.001	1.888	2.230	169.2	154.3	162.6	147.5	223.598	222.622
11	-20.243	1.891	2.296	169.7	154.4	159.4	143.9	227.299	224.473
12	-21.841	1.822	2.348	169.5	153.7	160.8	145.0	229.109	223.776
13	-9.972	1.868	2.242	169.3	154.2	160.2	145.2	223.274	219.364
14	-13.252	1.865	2.300	168.7	153.2	160.1	144.8	235.794	232.422
15	55.868	1.863	2.100	175.0	161.0	155.4	141.2	348.365	345.229

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TABLE 17.0 Spacecraft Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 1

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		149.1	1057.3	344.5	-3.132	-0.119	-0.157
8781.5 (D)	30	-8.3	-10.3	80.4	0.050	-0.046	0.028
11482.4 (G)	28	-10.6	22.4	22.1	-0.073	0.070	0.055
14107.7 (D)	64	33.5	-20.9	95.2	0.132	-0.060	0.032
14107.7 (G)		33.5	-20.9	95.2	0.132	-0.060	0.032
15565.2 (G)	8	-1280.4	688.6	2227.9	-2.133	1.614	2.689
19433.4 (D)	67	61.0	-25.1	81.6	0.159	-0.081	0.020
19449.8 (G)		63.1	-27.7	81.8	0.160	-0.083	0.019

Run No. 2

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-68.9	-1017.4	-191.7	2.756	0.502	-0.096
8881.6 (D)	30	-84.8	64.1	97.1	-0.066	0.019	0.025
11560.5 (G)	31	24.3	0.186	32.9	-0.005	0.055	0.088
14214.5 (D)	46	64.1	-55.3	70.7	0.180	-0.092	0.047
14214.5 (G)		64.1	-55.3	70.7	0.180	-0.092	0.047
16271.1 (G)	10	-365.1	-88.5	108.5	-0.527	0.050	-0.045
19539.3 (D)	63	115.2	-54.1	71.3	0.250	-0.118	0.009
19550.0 (G)		117.3	-56.7	71.3	0.251	-0.121	0.008

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TABLE 17.0 Spacecraft Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 3

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		73.3	-436.5	-146.7	-3.642	0.167	-0.029
8840.2 (D)	30	-82.0	85.8	76.4	-0.080	0.018	0.030
11534.0 (G)	31	-8.0	-8.5	8.5	-0.076	0.050	0.018
14174.5 (D)	47	20.3	-31.7	67.8	0.124	-0.057	0.087
14174.5 (G)		20.3	-31.7	67.8	0.124	-0.057	0.087
16417.9 (G)	12	256.2	-51.2	-196.6	0.334	-0.065	0.169
19498.3 (D)	61	115.5	-61.3	72.9	0.236	-0.131	0.019
19498.3 (G)		115.5	-61.3	72.9	0.236	-0.131	0.019

Run No. 4

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-134.2	955.7	-7.8	-1.527	-0.176	-0.157
8813.8 (D)	29	49.1	-72.7	73.6	0.182	-0.076	0.052
11497.9 (G)	27	-16.1	26.9	19.3	-0.089	0.074	0.060
14134.6 (D)	52	37.6	-23.4	64.1	0.133	-0.070	0.080
14134.6 (G)		37.6	-23.4	64.1	0.133	-0.070	0.080
16006.0 (G)	8	-1480.7	2166.5	1674.7	-2.932	1.872	0.636
19462.3 (D)	61	85.2	-55.9	73.7	0.203	-0.108	0.031
19497.8 (G)		90.1	-63.6	74.8	0.205	-0.113	0.028

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TABLE 17.0 Spacecraft Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 5

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		498.6	102.7	127.5	0.542	0.452	0.411
8659.0 (D)	32	0.1	-7.2	78.6	0.085	-0.029	0.053
11328.0 (G)	23	-26.5	4.1	-4.3	-0.097	0.055	0.021
13993.3 (D)	61	6.6	-14.2	68.2	0.091	-0.040	0.083
13993.3 (G)		6.6	-14.2	68.2	0.091	-0.040	0.083
16933.9 (G)	19	6.4	-12.4	15.5	-0.048	0.046	0.072
19319.7 (D)	41	67.8	2.5	55.4	0.145	-0.073	0.044
19319.7 (G)		67.8	2.5	55.4	0.145	-0.073	0.044

Run No. 6

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		126.5	-662.1	9.8	-2.325	-0.044	-0.250
8729.6 (D)	31	-71.0	47.3	73.6	-0.045	0.011	0.043
11426.8 (G)	26	-45.3	18.0	-9.6	-0.138	0.074	-0.892
14056.6 (D)	58	32.7	-14.1	70.3	0.119	-0.061	0.078
14056.6 (G)		32.7	-14.1	70.3	0.119	-0.061	0.078
16487.7 (G)	13	-6.1	-39.1	-20.6	-0.025	0.042	0.084
19381.8 (D)	49	91.8	-15.2	55.9	0.197	-0.090	0.027
19382.6 (G)		91.8	-15.4	56.0	0.197	-0.090	0.027

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TABLE 170 Spacecraft Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 7

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-17.9	726.7	252.4	-0.285	0.075	0.040
8852.4 (D)	29	-218.9	195.7	104.3	-0.303	0.129	-0.004
11544.9 (G)	30	14.2	2.2	24.5	-0.034	0.054	0.025
14177.3 (D)	49	14.7	-22.7	86.3	0.100	-0.060	0.052
14179.3 (G)		15.0	-22.9	86.4	0.100	-0.060	0.052
16492.3 (G)	13	-34.8	-13.6	1.8	-0.106	0.012	0.054
19504.2 (D)	52	98.5	-38.8	71.8	0.228	-0.100	0.011
19504.2 (G)		98.5	-38.8	71.8	0.228	-0.100	0.011

Run No. 8

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-177.8	-318.5	-109.9	-3.246	-0.234	0.010
8805.5 (D)	30	-44.1	24.7	78.5	0.004	-0.011	0.023
11491.7 (G)	28	7.9	-8.9	31.3	-0.040	0.046	0.052
14146.2 (D)	49	8.4	-24.0	73.0	0.093	-0.051	0.057
14170.3 (G)		10.2	-25.7	74.4	0.092	-0.053	0.054
16339.6 (G)	10	-34.9	34.8	42.3	-0.108	0.014	0.044
19475.1 (D)	53	111.0	-29.6	63.4	0.234	-0.111	0.027
19475.1 (G)		111.0	-29.6	63.4	0.234	-0.111	0.027

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TABLE 17.0 Spacecraft Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 9

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		8.0	-1496.3	12.0	-2.730	-0.236	0.005
8781.7 (D)	29	-7.0	-32.9	68.1	0.054	-0.054	0.036
11484.8 (G)	27	-22.8	16.4	3.0	-0.093	0.073	0.069
14100.1 (D)	53	-8.5	0.6	78.2	0.048	-0.047	0.091
14100.1 (G)		-8.5	0.6	78.2	0.048	-0.047	0.091
16243.4 (G)	9	-688.6	243.4	1053.7	-1.002	0.409	-0.019
19426.9 (D)	64	57.4	-29.2	70.7	-0.150	-0.085	0.030
19483.3 (G)		63.8	-38.2	72.1	0.153	-0.092	0.025

Run No. 10

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		67.8	1551.5	-68.5	0.315	-0.090	-0.080
8860.0 (D)	29	-130.9	121.9	82.7	-0.156	0.060	0.029
11537.5 (G)	29	-18.7	-0.9	-6.9	-0.086	0.068	-0.012
14180.4 (D)	48	59.3	-45.2	77.0	0.180	-0.082	0.066
14180.4 (G)		59.3	-45.2	77.0	0.180	-0.082	0.066
16546.0 (G)	15	-98.5	46.4	42.1	-0.223	0.064	0.010
19507.2 (D)	60	118.6	-43.1	65.0	0.242	-0.119	0.022
19533.0 (G)		123.6	-49.9	65.6	0.246	-0.125	0.020

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TABLE 17.0 Spacecraft Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 11

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-293.4	-490.6	135.4	0.054	0.033	0.008
8790.9 (D)	30	-70.1	38.3	81.1	-0.036	0.010	0.030
14116.8 (D)	93	263.6	-190.6	89.0	0.503	-0.238	-0.006
14116.8 (G)		263.6	-190.6	89.0	0.503	-0.238	-0.006
16551.0 (G)	15	-157.0	38.5	54.8	-0.238	0.171	0.071
19442.1 (D)	52	63.4	-35.5	66.7	0.178	-0.077	0.012
19445.6 (G)		64.0	-36.0	66.7	0.178	-0.077	0.012

Run No. 12

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		32.6	311.7	264.9	3.352	0.014	0.232
8794.2 (D)	30	77.0	-78.2	67.4	0.220	-0.099	0.044
11463.0 (G)	27	-42.4	13.5	-0.8	-0.131	0.073	-0.051
14116.9 (D)	56	73.9	-49.6	74.9	0.200	-0.088	0.038
14116.9 (G)		73.9	-49.6	74.9	0.200	-0.088	0.038
16168.0 (G)	9	-1013.6	1334.2	2458.5	-1.758	1.228	0.329
19444.7 (D)	54	90.6	-18.9	63.6	0.206	-0.091	0.030
19476.7 (G)		96.5	-25.5	64.4	0.211	-0.097	0.026

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TABLE 17.0 Spacecraft Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 13

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		143.5	-432.8	373.7	3.762	0.198	0.016
8787.5 (D)	31	11.4	-32.9	73.6	0.099	-0.055	0.056
11462.9 (G)	28	-21.7	12.4	9.9	-0.102	0.056	0.007
14119.7 (D)	56	-33.2	-9.9	70.7	0.007	-0.042	0.157
14119.7 (G)		-33.2	-9.9	70.7	0.007	-0.042	0.157
19448.4 (D)	69	139.9	-51.7	82.4	0.268	-0.136	0.010
19448.4 (G)		139.9	-51.7	82.4	0.268	-0.136	0.010

Run No. 14

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		126.2	36.8	21.9	2.178	0.188	-0.039
8750.4 (D)	30	27.5	-53.0	81.7	0.129	-0.068	0.052
11430.8 (G)	26	-36.4	-3.4	-2.6	-0.126	0.055	-0.071
14075.8 (D)	59	34.9	-24.5	79.0	0.138	-0.058	0.046
14075.8 (G)		34.9	-24.5	79.0	0.138	-0.058	0.046
16136.7 (G)	8	1119.1	-2165.5	2192.1	2.931	-1.042	0.455
19401.9 (D)	54	88.9	-27.8	57.0	0.211	-0.088	0.025
19401.9 (G)		88.9	-27.8	57.0	0.211	-0.088	0.025

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TABLE 17.0 Spacecraft Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 15

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		311.8	959.7	-239.1	2.165	0.180	-0.397
8845.9 (D)	29	-145.4	152.7	91.4	-0.190	0.075	0.564
11528.4 (G)	30	21.0	-7.2	22.4	-0.027	0.040	0.038
14171.0 (D)	53	29.3	-20.7	96.9	0.131	-0.058	0.032
14171.0 (G)		29.3	-20.7	96.9	0.131	-0.058	0.032
17424.9 (G)	42	94.0	-28.7	54.8	0.112	0.010	0.065
19494.3 (D)	21	68.7	-31.0	53.4	0.180	-0.095	0.041
19547.5 (G)		76.2	-40.7	55.6	0.184	-0.104	0.037

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TABLE 18.0 **Agena Orbit Determination Errors, Orbit Plane Co-ordinates** (M = 4)

Run No. 1

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-194.8	-854.0	101.9	1.708	0.184	0.487
8781.5 (D)	154	-66.6	464.0	88.5	-0.332	0.024	-0.041
11482.4 (G)	49	2.7	-1.8	22.7	-0.050	0.034	0.011
14107.7 (D)	87	20.0	-20.8	45.8	0.105	-0.062	0.056
14107.7 (G)		20.0	-20.8	45.8	0.105	-0.062	0.056
15565.2 (G)	9	-171.8	-163.0	1026.9	0.479	0.012	0.981
19433.4 (D)	100	61.5	-50.8	72.3	0.166	-0.090	0.020
19449.8 (G)		63.5	-53.6	72.8	0.167	-0.092	0.018

Run No. 2

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-162.8	-1010.8	252.7	1.192	-0.188	0.092
8881.6 (D)	155	-5.6	325.8	349.2	-0.157	-0.038	-0.096
11560.5 (G)	58	1.1	7.5	21.6	-0.057	0.040	-0.007
14214.5 (D)	78	6.0	-23.2	69.1	0.086	-0.059	0.081
14214.5 (G)		6.0	-23.2	69.1	0.086	-0.059	0.081
16271.1 (G)	13	195.0	-104.5	-288.8	0.216	-0.143	0.118
19539.3 (D)	102	46.7	-44.3	68.2	0.153	-0.081	0.019
19550.0 (G)		47.8	-45.7	68.4	0.154	-0.082	0.019

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TABLE 18.0 Agena Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 3

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-300.0	-1389.2	12.8	0.022	-0.069	0.109
8840.2 (D)	153	- 63.5	496.5	79.7	-0.361	0.020	-0.049
11534.0 (G)	54	-9.4	9.7	13.8	-0.073	0.045	0.002
14174.5 (D)	82	31.4	-14.0	57.6	0.113	-0.071	0.060
14174.5 (G)		31.4	-14.0	57.6	0.113	-0.071	0.060
16417.9 (G)	16	114.4	-44.6	-63.4	0.127	-0.030	0.115
19498.3 (D)	88	117.2	-79.8	71.0	0.255	-0.129	0.015
19498.3 (G)		117.2	-79.8	71.0	0.255	-0.129	0.015

Run No. 4

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-63.0	12.6	-42.9	-2.880	-0.141	-0.210
8813.8 (D)	154	-43.1	393.4	98.1	0.268	0.490	-0.033
11497.9 (G)	49	-62.1	15.7	-43.2	-0.152	0.070	-0.059
14134.6 (D)	84	-1.3	-9.4	91.1	0.071	-0.049	-0.004
14134.6 (G)		-1.3	-9.4	91.1	0.071	-0.049	-0.004
16006.0 (G)	9	-333.4	195.9	1325.1	-0.413	0.358	0.338
19462.3 (D)	99	60.5	-27.9	76.3	0.153	-0.088	0.013
19497.8 (G)		64.9	-33.6	76.7	0.155	-0.092	0.010

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TABLE 18.0 Agena Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 5

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		114.1	-1026.3	30.6	-5.258	-0.124	0.254
8659.0 (D)	156	-98.4	454.9	81.6	-0.347	0.060	-0.019
11328.0 (G)	40	-35.4	11.5	3.1	-0.116	0.045	0.007
13993.3 (D)	98	22.1	-18.4	62.1	0.108	-0.056	0.065
13993.3 (G)		22.1	-18.4	62.1	0.108	-0.056	0.065
16933.9 (G)	31	-1.6	-4.0	4.9	-0.065	0.037	0.064
19319.7 (D)	81	63.9	8.4	36.6	0.156	-0.058	0.034
19319.7 (G)		63.9	8.4	36.6	0.156	-0.058	0.034

Run No. 6

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-101.8	-437.1	-155.2	1.012	0.024	0.099
8729.6 (D)	155	-68.2	437.8	83.4	-0.309	0.029	-0.031
11426.8 (G)	47	-13.6	0.2	14.1	-0.091	0.034	0.024
14056.6 (D)	88	22.8	-30.0	101.4	0.109	-0.066	-0.005
14056.6 (G)		22.8	-30.0	101.4	0.109	-0.066	-0.005
16487.7 (G)	17	148.6	-28.0	-52.3	0.202	0.027	0.175
19381.8 (D)	88	42.3	-28.9	57.1	0.136	-0.071	0.031
19382.6 (G)		42.6	-28.9	56.9	0.136	-0.071	0.031

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TABLE 18.0 Agena Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 7

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		82.7	-329.4	407.4	-0.060	0.241	0.067
8852.4 (D)	151	-27.4	339.8	86.3	-0.204	-0.016	-0.406
11544.9 (G)	54	7.3	0.1	22.0	-0.049	0.033	0.024
14177.3 (D)	79	12.4	-30.9	79.6	0.098	-0.065	0.026
14179.3 (G)		12.6	-31.0	79.5	0.098	-0.065	0.025
16492.3 (G)	17	10.1	21.4	6.6	0.013	0.111	0.133
19504.2 (D)	92	68.7	-45.9	66.6	0.173	-0.098	0.026
19504.2 (G)		68.7	-45.9	66.6	0.173	-0.098	0.026

Run No. 8

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		475.5	-1416.0	-599.9	2.381	-0.005	0.187
8805.5 (D)	153	-58.7	480.6	88.9	-0.347	0.015	-0.033
11491.7 (G)	50	20.0	0.1	36.8	-0.034	0.023	0.013
14146.2 (D)	85	32.5	-32.1	70.3	0.125	-0.073	0.075
14170.3 (G)		34.7	-34.8	72.0	0.125	-0.075	0.073
16339.6 (G)	14	267.6	-68.5	-202.5	0.319	-0.131	0.149
19475.1 (D)	96	63.3	-43.2	70.6	0.161	-0.095	0.026
19475.1 (G)		63.3	-43.2	70.6	0.161	-0.095	0.026

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TABLE 18.0 Agena Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 9

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-65.7	-634.6	153.1	-3.050	-0.045	-0.180
8781.7 (D)	155	-79.4	493.4	77.5	-0.371	0.037	-0.039
11484.8 (G)	50	-63.4	24.3	-25.9	-0.172	0.064	-0.059
14100.1 (D)	86	-96.4	92.4	-101.2	-0.102	0.021	0.619
14100.1 (G)		-96.4	92.4	-101.2	-0.102	0.021	0.619
16243.4 (G)	12	-207.5	8.1	94.2	-0.335	0.083	-0.001
19426.9 (D)	97	53.9	-45.9	60.9	0.151	-0.087	0.027
19483.3 (G)		59.4	-54.9	62.3	0.153	-0.093	0.022

Run No. 10

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		71.2	-472.3	-206.2	0.452	-0.039	-0.018
8860.0 (D)	155	-28.6	343.7	90.0	-0.208	-0.015	-0.034
11537.5 (G)	53	2.7	-1.1	34.1	-0.055	0.035	0.038
14180.4 (D)	80	6.3	13.4	56.5	0.069	-0.050	0.053
14180.4 (G)		6.3	13.4	56.5	0.069	-0.050	0.053
16546.0 (G)	18	105.2	-35.2	-31.0	0.069	-0.030	0.105
19507.2 (D)	93	60.0	-46.3	63.8	0.162	-0.093	0.029
19533.0 (G)		62.8	-50.5	64.5	0.163	-0.096	0.027

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TABLE 18.0 Agena Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 11

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		6.0	198.3	29.7	0.192	0.314	0.231
8790.9 (D)	151	-65.9	456.6	79.4	-0.326	0.024	-0.041
14116.8 (D)	136	94.6	-95.5	73.5	0.241	-0.118	-0.012
14116.8 (G)		94.6	-95.5	73.5	0.241	-0.118	-0.012
16551.0 (G)	19	50.4	-35.9	-18.5	0.023	-0.008	0.106
19442.1 (D)	89	65.5	-37.7	62.9	0.165	-0.092	0.035
19445.6 (G)		66.1	-38.2	63.0	0.165	-0.093	0.035

Run No. 12

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		291.3	-645.0	181.1	-1.176	-0.196	-0.138
8794.2 (D)	155	-65.6	461.2	88.9	-0.327	0.024	-0.035
11463.0 (G)	50	-30.8	7.7	2.5	-0.110	0.046	-0.015
14116.9 (D)	85	-0.7	0.5	64.3	0.061	-0.051	0.076
14116.9 (G)		-0.7	0.5	64.3	0.061	-0.051	0.076
16168.0 (G)	11	105.1	1.3	-15.4	0.100	-0.040	0.076
19444.7 (D)	95	43.0	-18.0	70.6	0.128	-0.074	0.028
19476.7 (G)		46.6	-22.0	71.4	0.129	-0.078	0.025

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TABLE 18.0 Agena Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 13

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-199.4	399.8	328.9	1.797	-0.163	0.124
8787.5 (D)	154	-62.4	457.2	79.4	-0.324	0.021	-0.035
11462.9 (G)	50	5.6	-4.5	18.5	-0.050	0.032	-0.024
14119.7 (D)	85	53.2	-64.0	83.4	0.165	-0.092	-0.004
14119.7 (G)		53.2	-64.0	83.4	0.165	-0.092	-0.004
19448.4 (D)	108	79.7	-59.1	73.7	-0.200	-0.100	-0.003
19448.4 (G)		79.7	-59.1	73.7	-0.200	-0.100	-0.003

Run No. 14

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		415.0	381.0	35.9	0.326	-0.177	-0.019
8750.4 (D)	155	-65.7	432.9	84.6	-0.304	0.025	-0.028
11430.8 (G)	46	-20.3	0.4	-2.4	-0.096	0.035	-0.026
14075.8 (D)	88	5.9	9.4	81.6	0.075	-0.044	0.006
14075.8 (G)		5.9	9.4	81.6	0.075	-0.044	0.006
16136.7 (G)	10	-153.0	-8.8	33.5	-0.247	0.118	0.069
19401.9 (D)	97	60.7	-40.5	79.2	0.152	-0.091	0.014
19401.9 (G)		60.7	-40.5	79.2	0.152	-0.091	0.014

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TABLE 18.0 Agena Orbit Determination Errors, Orbit Plane Co-ordinates (M = 4)

Run No. 15

T(sec)	OBS	Δu(ft)	Δv(ft)	Δw(ft)	Δu̇(fps)	Δv̇(fps)	Δẇ(fps)
6425.0 (D)		-213.2	1030.0	472.4	-1.345	0.064	0.203
8845.9 (D)	155	-62.8	477.5	92.3	-0.346	0.018	-0.056
11528.4 (G)	55	-7.0	1.2	16.3	-0.077	0.035	-0.007
14171.0 (D)	83	40.0	-33.5	74.4	0.130	-0.081	0.041
14171.0 (G)		40.0	-33.5	74.4	0.130	-0.081	0.041
17424.9 (G)	66	31.6	-3.0	40.2	0.008	0.036	0.046
19494.3 (D)	49	26.8	-8.6	26.4	0.128	-0.043	0.031
19547.5 (G)		33.1	-12.9	27.9	0.130	-0.050	0.029

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TABLE 19.0 Attitude Angle and Rate Errors for Maneuver Sequences (M = 4)

Run No. 1

T(sec)	OP	$\Delta\alpha_p$(deg)	$\Delta\alpha_y$(deg)	$\Delta\alpha_r$(deg)	$\Delta\omega_p$(°/sec)	$\Delta\omega_y$(°/sec)	$\Delta\omega_r$(°/sec)
14385.1	10	0.692	0.049	-0.062	-0.000060	-0.000019	-0.000007
15865.0	13	0.099	-0.141	-0.031	"	"	"
19746.5	21	0.276	0.104	-0.021	"	"	"

Run No. 2

11831.3	14	0.258	0.089	0.147	0.000046	-0.000026	-0.000010
14480.7	10	-0.013	0.034	0.106	"	"	"
16570.9	13	0.147	-0.011	0.116	"	"	"
19848.2	21	0.324	0.016	0.076	"	"	"

Run No. 3

T(sec)	OP	$\Delta\alpha_p$(deg)	$\Delta\alpha_y$(deg)	$\Delta\alpha_r$(deg)	$\Delta\omega_p$(°/sec)	$\Delta\omega_y$(°/sec)	$\Delta\omega_r$(°/sec)
11802.7	14	0.168	-0.009	-0.063	-0.000034	-0.000056	-0.000008
14465.0	10	0.781	0.473	0.094	"	"	"
16718.0	9	0.470	-0.579	-0.107	0.00122	-0.000059	0.000996
19793.1	21	0.452	0.043	0.098	-0.000034	-0.000056	-0.000008

Run No. 4

11759.0	14	-0.251	0.150	-0.008	0.000008	-0.000008	0.000032
14410.8	10	0.384	-0.188	-0.082	"	"	"
16306.2	13	-0.089	0.107	-0.013	"	"	"
19741.7	21	-0.692	0.025	-0.028	"	"	"

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TABLE 19.0 Attitude Angle and Rate Errors for Maneuver Sequences (M = 4)

Run No. 5

T(sec)	OP	$\Delta\alpha_p$(deg)	$\Delta\alpha_y$(deg)	$\Delta\alpha_r$(deg)	$\Delta\omega_p$(°/sec)	$\Delta\omega_y$(°/sec)	$\Delta\omega_r$(°/sec)
11622.9	14	0.099	0.027	0.124	0.000022	-0.000001	0.000044
14260.3	10	0.614	-0.074	0.002	"	"	"
17233.5	13	0.522	-0.197	0.123	"	"	"
19533.0	21	0.666	-0.029	0.048	"	"	"

Run No. 6

11696.7	14	-0.174	0.314	-0.008	0.000015	-0.000036	-0.000015
14339.1	10	0.439	0.066	-0.004	"	"	"
16787.9	13	0.063	0.039	-0.001	"	"	"
19641.9	21	0.331	-0.153	0.062	"	"	"

Run No. 7

T(sec)	OP	$\Delta\alpha_p$(deg)	$\Delta\alpha_y$(deg)	$\Delta\alpha_r$(deg)	$\Delta\omega_p$(°/sec)	$\Delta\omega_y$(°/sec)	$\Delta\omega_r$(°/sec)
11,807.0	14	0.292	0.017	0.173	-0.000002	+0.000016	-0.000010
14,466.2	10	-0.241	-0.002	0.144	"	"	"
16,792.3	13	-0.258	0.109	0.096	"	"	"
19,727.0	21	-0.247	-0.211	0.122	"	"	"

Run No. 8

11,781.1	14	-0.331	0.200	-0.386	-0.000017	-0.000010	-.000007
14,452.2	10	0.485	0.188	-0.228	"	"	"
16,640.0	13	0.318	0.364	-0.191	"	"	"
19,687.9	21	-0.132	0.215	-0.301	"	"	"

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TABLE 19.0 Attitude Angle and Rate Errors for Maneuver Sequences (M = 4)

Run No. 9

T(sec)	OP	$\Delta\alpha_p$(deg)	$\Delta\alpha_y$(deg)	$\Delta\alpha_r$(deg)	$\Delta\omega_p$(°/sec)	$\Delta\omega_y$(°/sec)	$\Delta\omega_r$(°/sec)
11739.1	14	0.194	0.054	0.028	0.000066	-0.000050	0.000009
14392.6	10	-0.518	-0.029	0.086	"	"	"
16543.0	13	0.161	0.055	0.038	"	"	"
19783.1	21	-0.598	-0.030	0.008	"	"	"

Run No. 10

11796.7	14	-0.345	0.180	0.467	-0.000016	0.000001	-0.000012
14443.9	10	-0.012	0.124	0.544	"	"	"
16846.1	13	-0.028	-0.108	0.558	"	"	"
19827.1	21	-0.476	-0.140	0.468	"	"	"

Run No. 11

T(sec)	OP	$\Delta\alpha_p$(deg)	$\Delta\alpha_y$(deg)	$\Delta\alpha_r$(deg)	$\Delta\omega_p$(°/sec)	$\Delta\omega_y$(°/sec)	$\Delta\omega_r$(°/sec)
14395.0	10	-0.101	0.005	0.148	0.000075	-0.000018	-0.000044
16851.1	13	-0.475	0.0002	0.113	"	"	"
19703.2	21	-0.003	-0.154	0.229	"	"	"

Run No. 12

11725.8	14	-0.841	0.024	0.048	0.000012	-0.000057	-0.000045
14375.0	10	-0.631	-0.193	0.033	"	"	"
16483.3	13	-0.297	0.355	-0.002	"	"	"
19728.7	21	-0.748	-0.075	0.058	"	"	"

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TABLE 19.0 Attitude Angle and Rate Errors for Maneuver Sequences (M = 4)

Run No. 13

T(sec)	OP	$\Delta\alpha_p$(deg)	$\Delta\alpha_y$(deg)	$\Delta\alpha_r$(deg)	$\Delta\omega_p$(°/sec)	$\Delta\omega_y$(°/sec)	$\Delta\omega_r$(°/sec)
11732.0	14	-0.529	-0.361	-0.411	0.000004	-0.000053	-0.000009
14400.0	16	-0.734	-0.068	-0.406	"	"	"
19653.2	21	0.084	-0.109	-0.386	"	"	"

Run No. 14

11697.0	14	0.004	-0.140	0.071	0.000031	0.000045	-0.000001
14343.0	10	0.061	-0.080	0.136	"	"	"
16437.1	13	0.530	0.034	0.008	"	"	"
19652.9	21	0.369	-0.305	0.089	"	"	"

Run No. 15

T(sec)	OP	$\Delta\alpha_p$(deg)	$\Delta\alpha_y$(deg)	$\Delta\alpha_r$(deg)	$\Delta\omega_p$(°/sec)	$\Delta\omega_y$(°/sec)	$\Delta\omega_r$(°/sec)
11792.0	14	0.235	0.030	-0.022	-0.000020	0.000027	-0.000038
14435.2	10	-0.595	0.114	-0.016	"	"	"
17724.8	13	0.735	-0.415	-0.026	"	"	"
19815.2	21	-0.308	0.160	-0.071	"	"	"

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4.0 STATISTICAL (SOPFMT) RESULTS

This Section presents results obtained from the STL Statistical Output Format (SOPFMT) program, which summarizes a number of the mission simulation results for each run and performs a statistical analysis on selected mission parameters. Reference 12 presents a detailed description of the SOPFMT program. A brief summary of the program output is presented below, together with a print-out identification key. The actual SOPFMT output for the M = 4 mission is presented in Table 20.0.

4.1 Summary of SOPFMT Program

The non-statistical information which is printed by SOPFMT for each mission simulation run is presented for the following mission points:

(1) Prior Spacecraft Apogee - This is the M-1 Spacecraft apogee and the data presented here are obtained immediately after completion of the NSR maneuver. The following data are presented:

(a) Coordinates

(b) OCI - Orbit Control Information listing the Operation Numbers of the Maneuvers performed during the mission and certain other information.

(c) 2IDV - Two Impulse Delta Velocity Information. These data are to be disregarded in Table 20.0 due to an error in the present program.

(2) Final Spacecraft Apogee - This is the M Spacecraft apogee. Coordinate information only is presented for this time.

(3) Prior Apogee MAC - This is the M-1 Spacecraft apogee and coordinate information required by McDonnell Aircraft for their terminal rendezvous guidance simulation is presented for this time.

(4) Prior Apogee Plus 18 Minutes MAC - This point occurs 18 minutes after the M-1 Spacecraft apogee and coordinate information required by McDonnell is presented for this time.

The statistical information which is compiled from the 15 run sample consists of sample means, standard deviations, and correlation coefficients for the coordinate information and sample means and variances for the 2IDV information. This information is presented in Differential Cylindrical Coordinates and Spherical Coordinates at both the prior apogee and final apogee times. In addition, statistical coordinate information for the MAC print is presented at prior apogee and 18 minutes after prior apogee.

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4.2 SOPFMT Print Key

The following format is used in the output print of the SOPFMT:

(1) Non-statistical information for each of the 15 noise runs. (Prior apogee and final apogee).

(2) Statistical information (prior apogee and final apogee).

(3) Non-statistical information for MAC for each of the 15 noise runs (prior apogee and 18 minutes later).

(4) Statistical information for MAC (prior apogee and 18 minutes later).

The detailed print identification keys and symbol definitions for each of these sets of data are presented on the pages immediately preceding the SOPFMT printout. In the statistical print the following notation is used to identify the sample means and the elements of the normalized covariance matrix:

m	-	Mean value
s_i	-	Standard deviation
$\rho_{ij} s_i s_j$	-	Covariance
ρ_{ij}	-	Correlation coefficient
i,j	=	1,2,3,4,5,6

For the Differential Cylindrical Coordinates, the i,j indices refer to the following variables:

1	=	Δr	4	=	$\Delta \dot{r}$
2	=	ΔD	5	=	ΔV_I
3	=	w_{AS}	6	=	$\dot{w}_{AS}$

For the Spherical Coordinates, the i,j indices refer to the following variables:

1	=	R_S	4	=	V_S
2	=	φ_S	5	=	A_{I_S}
3	=	λ_S	6	=	β_S

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4.2.1 Detailed Print Keys

(PROGRAMMERS NAME) GEMINI M = (NUMBER) CASE (NUMBER)

PRIOR APOGEE

COORD	(t_T)	(Δr)	(ΔD)	(w_{AS})	($\Delta\dot{r}$)	(ΔV_I)
	($\dot{w}_{AS}$)	(R_S)	(φ_S)	(λ_S)	(V_S)	(A_{I_S})
	(β_S)	(ΔR)	($\Delta\dot{R}$)	(Ψ_y)	(Ψ_p)	(a_S)
	(e_S)	(δ_{SA})	(Ω_{SA})	(ω_{SA})	(f_S)	-
OCI	(ΔV_{TA})	(ΔV_{TS})	(W_A)	(W_S)	($\theta_R - \dot{\theta}_R$)	(OCI)
	(OCI)	(OCI)	(OCI)	(OCI)	(OCI)	(OCI)
	(OCI)	(OCI)	(OCI)	(t_o)	-	-
2IDV	(τ)	(ΔV_{1R})	(ΔV_{1V})	(ΔV_{1w})	(ΔV_{2R})	(ΔV_{2V})
	(ΔV_{2w})	(ΔV_1)	(ΔV_2)	($\Delta V_1 + \Delta V_2$)	-	-

FINAL APOGEE

COORD	(t_T)	(Δr)	(ΔD)	(w_{AS})	($\Delta\dot{r}$)	(ΔV_I)
	($\dot{w}_{AS}$)	(R_S)	(φ_S)	(λ_S)	(V_S)	(A_{I_S})
	(β_S)	(ΔR)	($\Delta\dot{R}$)	(Ψ_y)	(Ψ_p)	(a_S)
	(e_S)	(δ_{SA})	(Ω_{SA})	(ω_{SA})	(f_S)	-

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STATISTICAL INFORMATION

PRIOR APOGEE

DIFFERENTIAL CYLINDRICAL COORDINATES

$(m_{\Delta r})$	$(m_{\Delta D})$	$(m_{w_{AS}})$	$(m_{\Delta \dot{r}})$	$(m_{\Delta V_I})$	$(m_{\dot{w}_{AS}})$
(s_1)	$(\rho_{12}\, s_1 s_2)$	$(\rho_{13}\, s_1 s_3)$	$(\rho_{14}\, s_1 s_4)$	$(\rho_{15}\, s_1 s_5)$	$(\rho_{16}\, s_1 s_6)$
(ρ_{12})	(s_2)	$(\rho_{23}\, s_2 s_3)$	$(\rho_{24}\, s_2 s_4)$	$(\rho_{25}\, s_2 s_5)$	$(\rho_{26}\, s_2 s_6)$
(ρ_{13})	(ρ_{23})	(s_3)	$(\rho_{34}\, s_3 s_4)$	$(\rho_{35}\, s_3 s_5)$	$(\rho_{36}\, s_3 s_6)$
(ρ_{14})	(ρ_{24})	(ρ_{34})	(s_4)	$(\rho_{45}\, s_4 s_5)$	$(\rho_{46}\, s_4 s_6)$
(ρ_{15})	(ρ_{25})	(ρ_{35})	(ρ_{45})	(s_5)	$(\rho_{56}\, s_5 s_6)$
(ρ_{16})	(ρ_{26})	(ρ_{36})	(ρ_{46})	(ρ_{56})	(s_6)

SPHERICAL COORDINATES

(m_{R_S})	(m_{φ_S})	(m_{λ_S})	(m_{V_S})	$(m_{A_{I_S}})$	(m_{β_S})
(s_1)	$(\rho_{12}\, s_1 s_2)$	$(\rho_{13}\, s_1 s_3)$	$(\rho_{14}\, s_1 s_4)$	$(\rho_{15}\, s_1 s_5)$	$(\rho_{16}\, s_1 s_6)$
(ρ_{12})	(s_2)	$(\rho_{23}\, s_2 s_3)$	$(\rho_{24}\, s_2 s_4)$	$(\rho_{25}\, s_2 s_5)$	$(\rho_{26}\, s_2 s_6)$
(ρ_{13})	(ρ_{23})	(s_3)	$(\rho_{34}\, s_3 s_4)$	$(\rho_{35}\, s_3 s_5)$	$(\rho_{36}\, s_3 s_6)$
(ρ_{14})	(ρ_{24})	(ρ_{34})	(s_4)	$(\rho_{45}\, s_4 s_5)$	$(\rho_{46}\, s_4 s_6)$
(ρ_{15})	(ρ_{25})	(ρ_{35})	(ρ_{45})	(s_5)	$(\rho_{56}\, s_5 s_6)$
(ρ_{16})	(ρ_{26})	(ρ_{36})	(ρ_{46})	(ρ_{56})	(s_6)

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FINAL APOGEE

DIFFERENTIAL CYLINDRICAL COORDINATES

$(m_{\Delta r})$	$(m_{\Delta D})$	$(m_{W_{AS}})$	$(m_{\Delta \dot{r}})$	$(m_{\Delta V_I})$	$(m_{\dot{W}_{AS}})$
(s_1)	$(\rho_{12}\, s_1 s_2)$	$(\rho_{13}\, s_1 s_3)$	$(\rho_{14}\, s_1 s_4)$	$(\rho_{15}\, s_1 s_5)$	$(\rho_{16}\, s_1 s_6)$
(ρ_{12})	(s_2)	$(\rho_{23}\, s_2 s_3)$	$(\rho_{24}\, s_2 s_4)$	$(\rho_{25}\, s_2 s_5)$	$(\rho_{26}\, s_2 s_6)$
(ρ_{13})	(ρ_{23})	(s_3)	$(\rho_{34}\, s_3 s_4)$	$(\rho_{35}\, s_3 s_5)$	$(\rho_{36}\, s_3 s_6)$
(ρ_{14})	(ρ_{24})	(ρ_{34})	(s_4)	$(\rho_{45}\, s_4 s_5)$	$(\rho_{46}\, s_4 s_6)$
(ρ_{15})	(ρ_{25})	(ρ_{35})	(ρ_{45})	(s_5)	$(\rho_{56}\, s_5 s_6)$
(ρ_{16})	(ρ_{26})	(ρ_{36})	(ρ_{46})	(ρ_{56})	(s_6)

SAMPLE MEAN

$(m_{\Delta V_{TA}})$	$(m_{\Delta V_{TS}})$	(m_{W_A})	(m_{W_S})	$m_{(\theta_R - \dot{\theta}_R)}$	(m_{t_o})
(m_T)	$(m_{\Delta V_1 + \Delta V_2})$	$(m_{V_{TS}})$			

SAMPLE VARIANCE

$(s^2_{\Delta V_{TA}})$	$(s^2_{\Delta V_{TS}})$	$(s^2_{W_A})$	$(s^2_{W_S})$	$s^2_{(\theta_R - \dot{\theta}_R)}$	$(s^2_{t_o})$
(s^2_T)	$(s^2_{\Delta V_1 + \Delta V_2})$	$(s^2_{V_{TS}})$			

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(PROGRAMMERS NAME) GEMINI M = (NUMBER) CASE (NUMBER)

PRIOR APOGEE FOR MAC

(t_T)	(Δr)	(ΔD)	(w_{AS})	($\Delta \dot{r}$)	(ΔV_I)
($\dot{w}_{AS}$)	(ΔV_{TS})	(ΔR)	($\Delta \dot{R}$)	(Ψ_y)	(Ψ_p)
(R_S)	(φ_S)	(λ_S)	(V_S)	(A_{I_S})	(β_S)

18 MINUTES LATER

(t_T)	(Δr)	(ΔD)	(w_{AS})	($\Delta \dot{r}$)	(ΔV_I)
($\dot{w}_{AS}$)	(ΔV_{TS})	(ΔR)	($\Delta \dot{R}$)	(Ψ_y)	(Ψ_p)
(R_S)	(φ_S)	(λ_S)	(V_S)	(A_{I_S})	(β_S)

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STATISTICAL INFORMATION

PRIOR APOGEE FOR MAC

DIFFERENTIAL CYLINDRICAL COORDINATES

$(m_{\Delta r})$	$(m_{\Delta D})$	$(m_{w_{AS}})$	$(m_{\Delta \dot{r}})$	$(m_{\Delta V_I})$	$(m_{\dot{w}_{AS}})$
(s_1)	$(\rho_{12}\ s_1 s_2)$	$(\rho_{13}\ s_1 s_3)$	$(\rho_{14}\ s_1 s_4)$	$(\rho_{15}\ s_1 s_5)$	$(\rho_{16}\ s_1 s_6)$
(ρ_{12})	(s_2)	$(\rho_{23}\ s_2 s_3)$	$(\rho_{24}\ s_2 s_4)$	$(\rho_{25}\ s_2 s_5)$	$(\rho_{26}\ s_2 s_6)$
(ρ_{13})	(ρ_{23})	(s_3)	$(\rho_{34}\ s_3 s_4)$	$(\rho_{35}\ s_3 s_5)$	$(\rho_{36}\ s_3 s_6)$
(ρ_{14})	(ρ_{24})	(ρ_{34})	(s_4)	$(\rho_{45}\ s_4 s_5)$	$(\rho_{46}\ s_4 s_6)$
(ρ_{15})	(ρ_{25})	(ρ_{35})	(ρ_{45})	(s_5)	$(\rho_{56}\ s_5 s_6)$
(ρ_{16})	(ρ_{26})	(ρ_{36})	(ρ_{46})	(ρ_{56})	(s_6)

18 MINUTES LATER

DIFFERENTIAL CYLINDRICAL COORDINATES

$(m_{\Delta r})$	$(m_{\Delta D})$	$(m_{w_{AS}})$	$(m_{\Delta \dot{r}})$	$(m_{\Delta V_I})$	$(m_{\dot{w}_{AS}})$
(s_1)	$(\rho_{12}\ s_1 s_2)$	$(\rho_{13}\ s_1 s_3)$	$(\rho_{14}\ s_1 s_4)$	$(\rho_{15}\ s_1 s_5)$	$(\rho_{16}\ s_1 s_6)$
(ρ_{12})	(s_2)	$(\rho_{23}\ s_2 s_3)$	$(\rho_{24}\ s_2 s_4)$	$(\rho_{25}\ s_2 s_5)$	$(\rho_{26}\ s_2 s_6)$
(ρ_{13})	(ρ_{23})	(s_3)	$(\rho_{34}\ s_3 s_4)$	$(\rho_{35}\ s_3 s_5)$	$(\rho_{36}\ s_3 s_6)$
(ρ_{14})	(ρ_{24})	(ρ_{34})	(s_4)	$(\rho_{45}\ s_4 s_5)$	$(\rho_{46}\ s_4 s_6)$
(ρ_{15})	(ρ_{25})	(ρ_{35})	(ρ_{45})	(s_5)	$(\rho_{56}\ s_5 s_6)$
(ρ_{16})	(ρ_{26})	(ρ_{36})	(ρ_{46})	(ρ_{56})	(s_6)

SAMPLE MEAN

($m_{\Delta V_{TS}}$ at prior apogee) ($m_{\Delta V_{TS}}$ 18 minutes later)

SAMPLE VARIANCE

($s^2_{\Delta V_{TS}}$ at prior apogee) ($s^2_{\Delta V_{TS}}$ 18 minutes later)

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4.2.2 Symbol Definitions

The following list presents the definitions of the symbols used in the print key. The definitions are presented in the row order in which they appear in the first key.

t_T - Time from Agena liftoff (seconds)

Δr - Difference in the magnitudes of the two radius vectors; "up" direction difference with respect to the Agena (feet)

$\Delta r = R_S - R_A$

$R_S = |\bar{R}_S|$ Magnitude of radius vector from the center of the earth to the Spacecraft (feet)

$R_A = |\bar{R}_A|$ Magnitude of radius vector from the center of the earth to the Agena (feet)

ΔD - Arc length difference between the two vehicles referenced to the Agena orbit plane; relative "downrange" distance which is negative with the Agena leading (feet)

$\Delta D = \varphi a_A$

a_A = Osculating semi-major axis of Agena orbit (feet)

$$\cos \varphi = \frac{\bar{R}_S \cdot \bar{R}_A}{R_S \quad R_A}$$

w_{AS} - Out-of-plane component of the relative position difference between the two vehicles referenced to the Agena orbit plane (feet)

$w_{AS} = \hat{w}_A \cdot \bar{R}_S$

$\hat{u}_A$ - Unit vector pointing in the direction of the radius vector from the center of the Earth to the Agena

$\hat{v}_A$ - Unit vector orthogonal to $\hat{u}_A$ and the instantaneous angular momentum vector of the Agena; the unit vector points in the general direction of the velocity of the Agena

$\hat{w}_A$ - Unit vector in the direction of the angular momentum vector of the Agena.

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$\hat{u}_A, \hat{v}_A, \hat{w}_A$ - Orthogonal right handed coordinate system which rotates with the radius vector to the Agena

$\hat{u}_S, \hat{v}_S, \hat{w}_S$ - Same as $\hat{u}_A$, $\hat{v}_A$, $\hat{w}_A$, but with the Agena replaced by the Spacecraft

$\Delta\dot{r}$ - Difference in radial velocities (feet/sec)

$$\Delta\dot{r} = \overline{V}_S \cdot \hat{u}_S - \overline{V}_A \cdot \hat{u}_A$$

$V_S = |\overline{V}_S|$ Magnitude of Spacecraft inertial velocity vector (feet/sec)

$V_A = |\overline{V}_A|$ Magnitude of Agena inertial velocity vector (feet/sec)

ΔV_I - Difference in inertial velocities (feet/sec)

$$\Delta V_I = V_S - V_A$$

$\dot{w}_{AS}$ - Component of the velocity difference between the two vehicles normal to the Agena orbit plane (fps)

$$\dot{w}_{AS} = \overline{V}_S \cdot \hat{w}_A$$

R_S - See Δr

φ_S - Geocentric latitude of the Spacecraft (degrees)

λ_S - Longitude of the Spacecraft (degrees)

V_S - See $\Delta\dot{r}$

A_{I_S} - Azimuth of the inertial velocity vector of the Spacecraft with respect to the North Pole; positive in a clockwise direction (degrees)

β_S - Angle from the inertial velocity vector to the geocentric radius vector; for a flight path angle of zero degrees, β is 90° (degrees)

ΔR - Range between the two vehicles (feet)

$$\Delta R = \overline{R}_S - \overline{R}_A$$

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$\Delta\dot{R}$ - Range rate between the two vehicles (feet/sec)

$\Delta\dot{R} = \overline{V}_S - \overline{V}_A$

Ψ_y - Look angle out of the orbit plane of the Spacecraft from the Spacecraft to the Agena; positive in the direction of the angular momentum vector (degrees)

Ψ_p - Look angle in the orbit plane of the Spacecraft from the Spacecraft to the Agena; positive in the radial direction from the local horizontal plane of the Spacecraft (degrees)

a_S - Osculating semi-major axis of the Spacecraft orbit (feet)

e_S - Osculating eccentricity of the orbit of the Spacecraft

δ_{SA} - Relative inclination between the osculating orbit planes of the Agena and Spacecraft (degrees)

Ω_{SA} - Central angle in the orbit plane of the Agena between the position of the Agena and the ascending node of the Spacecraft (degrees)

f_S - True anomaly of the Spacecraft (degrees)

ΔV_{TA} - Sum of velocity increments used for Agena maneuvers up to the time of prior Spacecraft apogee (feet/sec)

ΔV_{TS} - Sum of velocity increments used for Spacecraft maneuvers up to the time of prior Spacecraft apogee - includes NSR maneuver at prior apogee (feet/sec)

W_A - Weight of the Agena at the time of prior Spacecraft apogee (lbs)

W_S - Weight of the Spacecraft at the time of prior Spacecraft apogee after the NSR maneuver (lbs)

$\theta_R - \dot{\theta}_R$ - Predicted in-plane orbital phase angle between the two vehicles at final apogee; positive if the Agena leads the Spacecraft (degrees)

θ_R - In-plane orbital phase angle between the two vehicles at the time of prior apogee (degrees)

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$\dot{\theta}_R$ - In-plane orbital phase angle catch-up rate at the time of prior apogee; positive if the Spacecraft has a smaller orbital period than the Agena (degrees per Spacecraft orbit)

OCI - Number of maneuver type; presented in sequence

t_o - Time from GLV SECO (seconds)

τ - Angle from final Spacecraft apogee to the first impulse in the two-impulse delta V calculation (degrees)

ΔV_{1R} - Component of first velocity impulse in radial direction (fps)

ΔV_{1V} - Component of first velocity impulse in downrange direction (fps)

ΔV_{1W} - Component of first velocity impulse in out-of-plane direction (fps)

ΔV_{2R} - Component of second velocity impulse in radial direction (fps)

ΔV_{2V} - Component of second velocity impulse in downrange direction (fps)

ΔV_{2W} - Component of second velocity impulse in out-of-plane direction (fps)

ω_{SA} - Argument of perigee of the Spacecraft with respect to the orbit plane of the Agena (degrees)

ΔV_1 - Magnitude of the first velocity impulse vector required by the Spacecraft for the two-impulse rendezvous maneuver (feet/sec)

$$\Delta V_1 = \left|\Delta \bar{V}_1\right|$$

ΔV_2 - Magnitude of the second velocity impulse vector required by the Spacecraft for the two-impulse rendezvous maneuver (feet/sec).

$$\Delta V_2 = \left|\Delta \bar{V}_2\right|$$

$\Delta V_1 + \Delta V_2$ - Magnitude of the total velocity required by the Spacecraft for the two-impulse rendezvous maneuver (fps)

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TABLE 20.0 SOPFMT PRINT OUT

GEMINI M = 4 Case -1

PRIOR APOGEE

COORD	19815.22460	-90187.25000	1	-718431.9531	-1553.201171	1	-.3223539591	52.52368164
	-2.233005523	21794818.25	2	-25.66205668	58.85671520	2	25426.81005	75.98653507
	90.02862548	721849.0937	3	834.3171005	.1294971630	3	6.236791372	21816988.75
	.0011323487	.0064815429	4	139.0736484	245.2579841	4	333.7908287	
OCI	.00000000 00	137.1967353	5	7004.666625	7442.494628	5	357.4448318	10.00000000
	13.00000000	21.00000000	6	13394.56738		6		
2IDV	345.0000000	62.60971593	1	-.6687515080	1.649693027	1	14.79371643	-30.32884979
	-1.513244152	62.63501548	2	33.77844095	96.41345596	2		

FINAL APOGEE

COORD	25208.29541	-90816.25000	3	130433.2265	-1250.178222	3	-.0034153461	53.41284179
	-.3787965774	21794482.00	4	-25.47315216	36.67623615	4	25427.12353	75.63216876
	90.02882385	158577.2246	5	160.3194503	179.4486923	5	34.76763200	21816852.75
	.0011421426	.0033962637	6	104.9274988	281.5760116	6	333.8393554	

KENEHAN GEMINI M=4 CASE - 2

PRIOR APOGEE

COORD	19913.26489	-89709.50000	1	-723636.5390	-2175.011718	1	.4614802599	52.59863281
	1.885028839	21792720.25	2	-24.19722867	65.11896705	2	25430.40747	73.50516605
	90.02141857	726826.0781	3	841.1941299	.1688174400	3	6.142677009	21818969.75
	.0012597969	.0071217668	4	51.51921367	323.8719940	4	342.7172241	
OCI	.00000000 00	311.8386268	5	7004.666625	7294.886535	5	357.5110168	14.00000000
	10.00000000	13.00000000	6	21.00000000	13492.60766	6		
2IDV	345.0000000	58.95801687	1	-.1201356323	-3.619602561	1	6.689174652	-32.80796051
	-3.812517017	59.06914281	2	33.69929647	92.76843929	2		

FINAL APOGEE

COORD	25306.60009	-90256.75000	3	115118.6757	-1773.068359	3	.8455717563	53.41918945
	3.621692657	21792374.00	4	-23.97625589	42.91820240	4	25430.74145	73.17790603
	90.02163314	145983.1699	5	142.9963951	179.1045799	5	38.03911066	21818849.75
	.0012708134	.0093959541	6	30.04573154	347.5612831	6	342.6952590	

KENEHAN GEMINI M=4 CASE - 3

PRIOR APOGEE

COORD	19871.86645	-101313.7500	1	-692592.6640	503.3916015	1	-.0093337297	58.89550781

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	-4.817237854	21781634.50	2	-24.65264725	62.88236427	2	25436.39208	74.15509319
	90.02973175	697546.2812	3	805.3429260	-.0310224953	3	7.444659769	21807035.00
	.0012751468	.0109307475	4	185.1464004	197.0857353	4	335.9584655	
OCI	248.5450267	122.9030675	5	6822.488769	7455.403381	5	-.6801442206	14.00000000
	10.00000000	9.000000000	6	21.00000000	13451.20922	6		
2IDV	335.0000000	89.17924118	1	-5.137422978	6.271107554	1	49.73646736	-55.86479949
	3.347188711	89.54695415	2	74.87186050	164.4188137	2		

FINAL APOGEE

COORD	25260.91699	-102044.2500	3	263980.0859	872.8857421	3	.4575551748	59.95678710
	-2.832382202	21781275.50	4	-24.43991780	40.70511436	4	25436.73046	73.81948947
	90.02993392	282152.0429	5	311.4681930	-179.8030605	5	20.85686898	21806897.00
	.0012858451	.0067793976	6	200.4873294	184.2065582	6	335.9980659	

KENEHAN GEMINI M=4 CASE - 4

PRIOR APOGEE

COORD	19824.92919	-91817.50000	1	-720680.1171	-953.7021484	1	1.313844203	52.48022460
	-1.027660369	21814742.50	2	-25.41662621	60.01564025	2	25401.51367	75.54909992
	89.89572238	724972.7656	3	837.6193923	.0784266637	3	6.332586467	21813404.75
	.0018210080	.0034097963	4	130.8417663	135.2392330	4	92.03160381	
OCI	.00000000 00	206.6841182	5	7004.666625	7386.379394	5	-.9482809007	14.00000000
	10.00000000	13.00000000	6	21.00000000	13404.27197	6		
2IDV	345.0000000	68.74583435	1	-1.666621223	.6065757349	1	29.44903182	-26.39464569
	-1.045277461	68.76870822	2	39.56027507	108.3289833	2		

FINAL APOGEE

COORD	25216.60229	-90496.75000	3	155214.0390	-613.9980468	3	.6106472015	51.11840820
	.8587360382	21814371.50	4	-25.22203803	37.83754539	4	25401.86083	75.19933319
	89.89605522	179358.3339	5	186.3952293	179.7704124	5	30.09887599	21813259.00
	.0018148824	.0025226090	6	40.14482879	228.5469360	6	91.71160984	

KENEHAN GEMINI M=4 CASE - 5

PRIOR APOGEE

COORD	19641.15527	-92236.25000	1	-706536.5312	-695.4458007	1	-.2130775451	53.81127929
	-2.165817260	21790877.25	2	-27.99969625	46.64886474	2	25428.51293	81.97132205
	90.07587051	710355.8828	3	820.9444656	.0615519816	3	6.535598278	21812016.25

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	.0016409546	.0052135521	4	157.6218547	254.4057006	4	306.1278572	
OCI	.00000000 00	177.7149734	5	7004.666625	7405.773010	5	-1.881947040	14.00000000
	10.00000000	13.00000000	6	21.00000000	13220.49804	6		
2IDV	345.0000000	69.66481018	1	-2.045480310	2.118108302	1	31.02638626	-24.73222351
	-.2836644500	69.72701072	2	39.67870950	109.4057197	2		

FINAL APOGEE

COORD	25033.17065	-93602.50000	3	161628.3789	-525.1386718	3	.2103719711	55.45092773
	-.1153697967	21790549.00	4	-27.88944172	24.50752544	4	25428.77514	81.57022762
	90.07600307	186332.3613	5	195.1670837	-179.8131141	5	29.94345378	21811811.00
	.0016461572	.0014056709	6	101.1544914	313.0335159	6	306.2365760	

KENEHAN GEMINI M=4 CASE - 6

PRIOR APOGEE

COORD	19735.28588	-91792.00000	1	-727362.5234	1576.673828	1	.5517239570	53.69726562
	-1.853019714	21805309.25	2	-26.57968473	54.03198814	2	25412.44970	77.95000648
	89.91379070	731335.9453	3	845.0900573	-.1205335557	3	6.258081674	21813315.25
	.0015487423	.0058881693	4	222.8117389	58.90849399	4	76.37318706	
OCI	.00000000 00	246.3533840	5	7004.666625	7350.204223	5	-.9804041385	14.00000000
	10.00000000	13.00000000	6	21.00000000	13314.62866	6		
2IDV	345.0000000	63.49029254	1	-.8202311471	3.199602395	1	15.56141281	-30.33908843
	2.928314775	63.57615470	2	34.22269487	97.79884910	2		

FINAL APOGEE

COORD	25127.30468	-90745.25000	3	130499.6044	1843.458007	3	.2676978111	52.61083984
	.0435819626	21804957.50	4	-26.41639971	31.86886596	4	25412.76293	77.57778739
	89.91409397	158667.7109	5	159.9183406	-179.1868839	5	34.71330976	21813149.50
	.0015456392	.0048445975	6	271.4174575	12.89987564	6	76.01839160	

KENEHAN GEMINI M=4 CASE - 7

PRIOR APOGEE

COORD	19839.85473	-92754.25000	1	-715260.2031	270.3105468	1	.9347372055	52.03540039
	-1.441848754	21810149.00	2	-24.85919737	61.82596874	2	25402.45874	74.56355953
	89.85841083	719750.7890	3	831.1358032	-.0184826064	3	6.467733681	21805842.25
	.0024790646	.0033301680	4	190.4410133	72.97701072	4	94.70894527	
OCI	.00000000 00	168.1077499	5	7004.666625	7415.213195	5	-1.018418759	14.00000000

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	10.00000000	13.00000000	6	21.00000000	13419.19750	6		
2IDV	345.0000000	75.59371185	1	-2.681929349	1.878597855	1	45.19162750	-21.92070770
	.8819722533	75.66459560	2	50.23523139	125.8998270	2		

FINAL APOGEE

COORD	25228.54443	-90806.25000	3	185401.0078	642.1220703	3	.1158070564	49.96093750
	.4421758652	21809752.00	4	-24.65171813	39.65307712	4	25402.83032	74.22399234
	89.85879135	206081.8691	5	220.5556316	-179.8017101	5	25.90147471	21805685.25
	.0024715778	.0019574479	6	300.9668655	325.0496215	6	94.46533393	

KENEHAN GEMINI M=4 CASE - 8

PRIOR APOGEE

COORD	19803.65869	-94223.75000	1	-713346.9609	-445.5703125	1	.4426422119	53.97094726
	-1.107364654	21808552.50	2	-25.86477446	58.48828697	2	25406.98046	76.37621212
	89.90062236	717884.9062	3	828.5465316	.0384305902	3	6.608054041	21810412.75
	.0017365531	.0027563370	4	152.9994029	117.8507204	4	87.28257274	
OCI	.00000000 00	233.0453605	5	7004.666625	7363.434936	5	-1.073409080	14.00000000
	10.00000000	13.00000000	6	21.00000000	13383.00146	6		
2IDV	345.0000000	76.01844406	1	-2.919121205	1.025476351	1	44.66269302	-21.40182495
	-.2764447182	76.08138179	2	49.52646398	125.6078453	2		

FINAL APOGEE

COORD	25194.36547	-92915.75000	3	184644.7734	-118.0712890	3	-.1006159782	52.61547851
	.8528547287	21808181.75	4	-25.68093633	36.32021331	4	25407.32006	76.01797676
	89.90094757	206323.5644	5	220.5052967	179.9612731	5	26.52369046	21810254.00
	.0017313892	.0019485418	6	9.652406334	263.8759498	6	86.95091629	

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PRIOR APOGEE

COORD	19836.44140	-89638.75000	1	-727699.3359	-215.6962890	1	2.337392240	52.12988281
	-1.394008636	21798032.00	2	-25.31092596	60.36603069	2	25422.44360	75.35507965
	89.99423122	731087.0781	3	847.5525207	.0202025482	3	6.090142190	21815919.50
	.82610209-03	.0031925351	4	167.8648262	183.2273578	4	7.003968179	
OCI	.00000000 00	151.1339492	5	7004.666625	7430.013732	5	357.4928321	14.00000000
	10.00000000	13.00000000	6	21.00000000	13415.78417	6		
2IDV	345.0000000	58.73860836	1	-.1413670108	1.511449500	1	7.570758819	-32.84468078

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	.1560261547	58.75822067	2	33.70628643	92.46450710	2		

FINAL APOGEE

COORD	25229.00390	-89848.25000	3	116279.9472	110.6376953	3	2.446084022	52.53906250
	.4071998596	21797687.75	4	-25.11378526	38.18304443	4	25422.76782	75.00724315
	89.99446582	146681.7617	5	142.4108924	-179.9461307	5	37.62098312	21815789.25
	.83530828-03	.96274249-03	6	342.7448539	10.91427636	6	6.644740104	

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PRIOR APOGEE

COORD	19888.14624	-91392.00000	1	-721912.0859	-1142.011718	1	.9472396374	53.32080078
	-.9068069458	21815858.00	2	-24.39115452	63.97440910	2	25403.93457	73.81612777
	89.94642448	726032.8671	3	838.6835784	.0930413520	3	6.286621749	21819794.25
	.95229870-03	.0036289049	4	122.3625431	156.6159629	4	79.12747859	
OCI	.00000000 00	177.5919094	5	7004.666625	7407.946777	5	357.4204139	14.00000000
	10.00000000	13.00000000	6	21.00000000	13467.48901	6		
2IDV	345.0000000	63.96306133	1	-.9954022988	.3434566408	1	17.87744140	-29.39923858
	-1.360692486	63.97172784	2	34.43500518	98.40673255	2		

FINAL APOGEE

COORD	25281.86108	-90838.75000	3	132494.6699	-768.7612304	3	.3551609516	52.87011718
	.8629865646	21815499.25	4	-24.17428064	41.77420043	4	25404.28393	73.48548889
	89.94671249	160376.9082	5	161.9978733	179.6641025	5	34.32674694	21819677.75
	.94954253-03	.0028059151	6	46.36954116	235.5591011	6	78.41463947	

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PRIOR APOGEE

COORD	19792.09594	-93122.00000	1	-722726.4765	-1078.047851	1	.6476192474	53.90234375
	-1.608005523	21798982.50	2	-25.89996504	58.17247581	2	25417.39038	76.46746444
	89.92102622	726795.1171	3	840.0772857	.0894610155	3	6.415063142	21809140.00
	.0014549009	.0045977204	4	140.0634212	146.6370582	4	71.40545749	
OCI	.00000000 00	177.3810615	5	7004.666625	7407.476806	5	-1.092389047	10.00000000
	13.00000000	21.00000000	6	13371.43872		6		
2IDV	345.0000000	69.51681041	1	-1.808828979	1.213581413	1	29.35951614	-26.21645355
	-1.031133964	69.55092811	2	39.37444400	108.9253721	2		

FINAL APOGEE

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COORD	25182.33837	-92163.00000	3	157222.7500	-766.4619140	3	.4599466324	52.94506835
	.3256053924	21798621.25	4	-25.71722888	36.00720310	4	25417.71972	76.10835075
	89.92132854	181912.7187	5	189.4601249	179.7186717	5	30.23387813	21808983.25
	.0014529392	.0021450783	6	70.33063316	219.0885295	6	70.99002265	

KENEHAN GEMINI M=4 CASE - 12

PRIOR APOGEE

COORD	19802.83984	-94185.25000	1	-696468.0781	-462.0595703	1	.9361474514	53.87402343
	-1.117908477	21802665.00	2	-25.68406820	58.28763771	2	25413.83496	76.00300025
	89.93344497	700998.0781	3	809.7642898	.0406984794	3	6.809756577	21810403.75
	.0012145722	.0027963316	4	152.4492130	132.6487979	4	73.07647514	
OCI	.00000000 00	260.4725494	5	7004.666625	7336.223937	5	-1.211915135	14.00000000
	10.00000000	13.00000000	6	21.00000000	13382.18261	6		
2IDV	340.0000000	76.97958469	1	-3.199110239	1.132430464	1	35.04548263	-42.46623229
	-.1572185531	77.05435085	2	55.05988931	132.1142387	2		

FINAL APOGEE

COORD	25193.48193	-93407.00000	3	203633.5429	-124.4863281	3	.6681616306	53.13867187
	.8341455459	21802299.50	4	-25.49537682	36.11728763	4	25414.17138	75.64825439
	89.93373775	223552.1953	5	241.3146991	179.9629249	5	24.43109107	21810250.75
	.0012125849	.0019089668	6	10.40139043	277.5623245	6	72.56719779	

KENEHAN GEMINI M=4 CASE - 13

PRIOR APOGEE

COORD	19759.69091	-90345.50000	1	-714008.2187	-8238.992187	1	.1126518249	51.91210937
	-11.91466522	21805353.00	2	-26.35251688	55.70557785	2	25412.04174	77.43502807
	89.93075084	717937.2734	3	829.1770706	.6907502636	3	6.294469356	21812703.75
	.0012547164	.0344810807	4	139.2403659	144.4023380	4	74.48627185	
OCI	.00000000 00	108.0438833	5	7004.666625	7468.097167	5	-1.026862323	14.00000000
	16.00000000	21.00000000	6	13339.03369		6		
2IDV	345.0000000	66.13114738	1	-1.244067668	8.832347512	1	23.87188339	-27.70946502
	-8.005507707	66.72995281	2	37.44021129	104.1701641	2		

FINAL APOGEE

COORD	25151.40649	-89532.50000	3	145544.8925	-8077.978515	3	-.1424241066	51.10815429
	-9.890603065	21805003.25	4	-26.18246984	33.54049396	4	25412.35839	77.06723117

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	89.93103885	170580.5136	5	176.4958839	176.8264636	5	31.46891760	21812548.75
	.0012523140	.0307684680	6	136.7602615	149.5854911	6	74.03323936	

KENEHAN GEMINI M=4 CASE - 14

PRIOR APOGEE

COORD	19736.62280	-92785.75000	1	-712815.6718	1028.763671	1	-.0429625511	53.45727539
	-3.131217956	21795400.75	2	-26.56027483	54.16986942	2	25420.87231	77.87798023
	89.94185161	716858.3906	3	828.0738906	-.0760059785	3	6.503514587	21807950.50
	.0011666599	.0075602798	4	199.0948181	98.53637504	4	60.50144147	
OCI	.00000000 00	288.4577903	5	7004.666625	7313.540771	5	-1.195724099	14.00000000
	10.00000000	13.00000000	6	21.00000000	13315.96557	6		
2IDV	345.0000000	71.86914062	1	-2.228994160	4.361925303	1	35.49164199	-24.05113220
	2.560416549	72.03588104	2	42.94961404	114.9854946	2		

FINAL APOGEE

COORD	25126.64160	-92125.75000	3	169130.5273	1291.307617	3	-.0536615848	52.82177734
	-1.172422409	21795042.75	4	-26.39595484	32.01499843	4	25421.18798	77.50598621
	89.94212818	192175.9355	5	203.1870574	-179.5577468	5	28.42357563	21807774.75
	.0011666344	.0043043146	6	232.5068531	67.90642452	6	60.02458763	

KENEHAN GEMINI M=4 CASE - 15

PRIOR APOGEE

COORD	19895.67236	-86843.75000	1	-712416.1171	-2060.039062	1	.4993739128	51.37963867
	-3.393383026	21777225.50	2	-24.36930775	63.90684986	2	25449.63452	73.79497337
	90.10828304	714877.3359	3	828.9530563	.1742546633	3	6.044998049	21820968.50
	.0027550300	.0093753604	4	142.8188171	258.7391319	4	316.5801429	
OCI	.00000000 00	188.0795478	5	7004.666625	7399.572448	5	357.6472816	14.00000000
	10.00000000	13.00000000	6	21.00000000	13475.01513	6		
2IDV	345.0000000	53.04424905	1	.6438829899	2.698618531	1	-4.151699066	-35.33118438
	-1.861533254	53.11675310	2	35.62294912	88.73970222	2		

FINAL APOGEE

COORD	25289.79394	-88598.75000	3	95297.35937	-1737.196777	3	1.594739437	53.58911132
	-1.703803539	21776894.00	4	-24.15189599	41.70570278	4	25449.95068	73.46431064
	90.10841178	129859.0761	5	121.3793745	178.9532775	5	42.89625883	21820847.00
	.0027635925	.0059724418	6	130.3171615	273.2504119	6	316.6830177	

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STATISTICAL INFORMATION

PRIOR APOGEE

DIFFERENTIAL CYLINDRICAL COORDINATES

-92156.48242	-715059.5312	1	-1042.709197	.5731416195	1	53.33260059	-2.415128052
3081.974212	-19779700.75	2	-2524963.281	449.2144241	2	-4852.037597	574.0460205
-.6477426961	9908.049926	3	856556.3203	-2716.830169	3	10289.76928	-8100.175476
-.3761751540	.0396946319	4	2177.890075	237.2895832	4	1422.426620	4290.530334
.2221783958	-.4179760888	5	.1660809628	.6560287326	5	-.3445172496	.6360939368
-.9273630157	.6117473021	6	.3847233318	-.3093447313	6	1.697639152	-.1813840475
.0641084322	-.2813867777	7	.6780667752	.3337304517	7	-.0367748700	2.905377388

SPHERICAL COORDINATES

21799487.25	-25.58667373	1	58.83010673	25419.04394	1	76.05377388	89.96667575
10801.47717	-766.4480667	2	-1524.185073	-139597.6660	2	388.6384811	-638.9909439
-.0712379711	.9960658103	3	4.606538176	1.875777572	3	-2.087158143	.0047902189
-.0303301476	.9940463006	4	4.652431905	6.132337868	4	-9.812742233	.0048135145
-.9798875227	.1427823510	5	.0999372219	13.18920969	5	-2.242669224	.8401537910
.0169858578	-.9892183319	6	-.9957153499	-.0802733311	6	2.118239969	.0034947192
-.8481933325	.0689525977	7	.0148342488	.9133207351	7	.0236548628	.0697455806

FINAL APOGEE

DIFFERENTIAL CYLINDRICAL COORDINATES

-91879.84960	156434.8906	1	-732.9952087	.5154417753	1	53.17049121	-.5229599252
3048.868804	-108941479.0	2	-2351264.687	455.4999580	2	-5563.632934	475.5335960
-.8802517280	40592.67236	3	25544793.50	-10878.25744	3	43786.65478	-14046.59191
-.3495036438	.2851961590	4	2206.536285	169.2459106	4	1202.323379	4399.791809
.2221315373	-.3984486051	5	.1140427626	.6725729182	5	.0852948008	.4701555073
-.8352403119	.4937258139	6	.2494031507	.0580463479	6	2.184782862	-.1918409839
.0545405485	-.1210041744	7	.6972653568	.2444438897	7	-.0307050736	2.859716385

SAMPLE MEAN

16.56966829	197.0003013	1	6992.521118	7391.777099	1	118.4271202	13389.79211
344.0000000	110.6965389	2	309.1179733		2		

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SAMPLE VARIANCE

3843.754516	3369.433532	3	2065.078948	2425.118713	3	28578.76025	4812.884521
7.333333313	368.4671516	4	3493.469360		4		

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KENEHAN GEMINI M=4 CASE - 1

PRIOR APOGEE FOR MAC

19815.22460	-90187.25000	1	-718431.9531	-1553.201171	1	-.3223539591	52.52368164
-2.233005523	137.1967353	2	721849.0937	834.3171005	2	.1294971630	6.236791372
21794818.25	-25.66205668	3	58.85671520	25426.81005	3	75.98653507	90.02862548

18 MINUTES LATER

20895.22460	-89998.00000	1	-547958.1250	-1451.859375	1	.5294580161	52.71533203
1.570612907	137.1967353	2	553167.8359	638.0817947	2	.1491527632	8.646473526
21787640.00	4.454955637	3	122.2573242	25441.96557	3	61.40412044	90.00104236

KENEHAN GEMINI M=4 CASE - 2

PRIOR APOGEE FOR MAC

19913.26489	-89709.50000	1	-723636.5390	-2175.011718	1	.4614802599	52.59863281
1.885028839	311.8386268	2	726826.0781	841.1941299	2	.1688174400	6.142677009
21792720.25	-24.19722867	3	65.11896705	25430.40747	3	73.50516605	90.02141857

18 MINUTES LATER

20993.26489	-88458.25000	1	-554886.0468	1666.470703	1	1.423736497	51.58349609
3.555001258	311.8386268	2	559792.0703	646.8755874	2	-.1810518931	8.365952610
21789696.00	7.110515832	3	127.5320882	25439.62353	3	61.89433145	89.99266815

KENEHAN GEMINI M=4 CASE - 3

PRIOR APOGEE FOR MAC

19871.86645	-101313.7500	1	-692592.6640	503.3916015	1	-.0093337297	58.89550781
-4.817237854	122.9030675	2	697546.2812	805.3429260	2	-.0310224953	7.444659769
21781634.50	-24.65264725	3	62.88236427	25436.39208	3	74.15509319	90.02973175

18 MINUTES LATER

20951.86645	-101030.2500	1	-501181.3046	-2984.376953	1	.3587721139	59.00292968
-1.490860939	122.9030675	2	509171.3671	584.5638198	2	.3467218727	10.78882205

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21775391.00	6.415974497	3	125.5988378	25449.71069	3	61.71129465	89.99614429

KENEHAN GEMINI M=4 CASE - 4

PRIOR APOGEE FOR MAC

19824.92919	-91817.50000	1	-720680.1171	-953.7021484	1	1.313844203	52.48022460
-1.027660369	206.6841182	2	724972.7656	837.6193923	2	.0784266637	6.332586467
21814742.50	-25.41662621	3	60.01564025	25401.51367	3	75.54909992	89.89572238

18 MINUTES LATER

20904.92944	-91621.25000	1	-549937.2343	-296.3847656	1	-1.193209350	52.44604492
1.269344329	206.6841182	2	556704.5000	637.1228942	2	.0281173670	8.753139853
21839257.25	4.779282629	3	122.9853086	25379.56176	3	61.46155786	90.01930236

KENEHAN GEMINI M=4 CASE - 5

PRIOR APOGEE FOR MAC

19641.15527	-92236.25000	1	-706536.5312	-695.4458007	1	-.2130775451	53.81127929
-2.165817260	177.7149734	2	710355.8828	820.9444656	2	.0615519816	6.535598278
21790877.25	-27.99969625	3	46.64886474	25428.51293	3	81.97132205	90.07587051

18 MINUTES LATER

20721.15527	-91869.50000	1	-532186.1796	-1053.597656	1	.7913469076	53.74414062
.5410085916	177.7149734	2	537558.9375	620.7277679	2	.1129728528	9.143908381
21768264.75	-1.363837465	3	112.7974863	25463.15283	3	61.10938739	90.01021003

KENEHAN GEMINI M=4 CASE - 6

PRIOR APOGEE FOR MAC

19735.28588	-91792.00000	1	-727362.5234	1576.673828	1	.5517239570	53.69726562
-1.853019714	246.3533840	2	731335.9453	845.0900573	2	-.1205335557	6.258081674
21805309.25	-26.57968473	3	54.03198814	25412.44970	3	77.95000648	89.91379070

18 MINUTES LATER

20815.28613	-90769.00000	1	-555615.3593	-142.2402343	1	.9037419632	52.63842773
-1.823256015	246.3533840	2	561947.0781	646.0339355	2	.0188369532	8.568453907

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21830824.75	2.362497419	3	118.0918474	25390.12744	3	61.19399404	89.99813079

KENEHAN GEMINI M=4 CASE - 7

PRIOR APOGEE FOR MAC

19839.85473	-92754.25000	1	-715260.2031	270.3105468	1	.9347372055	52.03540039
-1.441848754	168.1077499	2	719750.7890	831.1358032	2	-.0184826064	6.467733681
21810149.00	-24.85919737	3	61.82596874	25402.45874	3	74.56355953	89.85841083

18 MINUTES LATER

20919.85498	-94121.00000	1	-542419.5000	-282.9746093	1	-3.363879799	53.74389648
-.2038707733	168.1077499	2	550035.8828	626.2285995	2	.0304363279	9.142909646
21845612.50	5.809789717	3	124.3705863	25367.34033	3	61.62912797	90.01677417

KENEHAN GEMINI M=4 CASE - 8

PRIOR APOGEE FOR MAC

19803.65869	-94223.75000	1	-713346.9609	-445.5703125	1	.4426422119	53.97094726
-1.107364654	233.0453605	2	717884.9062	828.5465316	2	.0384305902	6.608054041
21808552.50	-25.86477446	3	58.48828697	25406.98046	3	76.37621212	89.90062236

18 MINUTES LATER

20883.65869	-94654.00000	1	-536952.1406	-192.8496093	1	-1.329744130	54.62768554
.6662535667	233.0453605	2	544354.8906	622.2995452	2	.0191483407	9.311030864
21833858.50	3.932163387	3	121.8359136	25384.36889	3	61.33252811	90.01160812

KENEHAN GEMINI M=4 CASE - 9

PRIOR APOGEE FOR MAC

19836.44140	-89638.75000	1	-727699.3359	-215.6962890	1	2.337392240	52.12988281
-1.394008636	151.1339492	2	731087.0781	847.5525207	2	.0202025482	6.090142190
21798032.00	-25.31092596	3	60.36603069	25422.44360	3	75.35507965	89.99423122

18 MINUTES LATER

20916.44165	-87398.25000	1	-561592.8281	-365.8281250	1	1.128804132	49.89550781
.3517236709	151.1339492	2	566496.1562	653.9196929	2	.0367217464	8.140149712

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21800039.25	5.088674545	3	123.4499988	25426.63012	3	61.50895357	90.00216197

KENEHAN GEMINI M=4 CASE - 10

PRIOR APOGEE FOR MAC

19888.14624	-91392.00000	1	-721912.0859	-1142.011718	1	.9472396374	53.32080078
-.9068069458	177.5919094	2	726032.8671	838.6835784	2	.0930413520	6.286621749
21815858.00	-24.39115452	3	63.97440910	25403.93457	3	73.81612777	89.94642448

18 MINUTES LATER

20968.14648	-90116.25000	1	-551216.6875	-293.4902343	1	.9468723535	52.18969726
1.543108940	177.5919094	2	557267.0312	641.1307830	2	.0271531911	8.585097551
21824765.50	6.667470455	3	126.3111877	25399.40087	3	61.80354547	90.02463245

KENEHAN GEMINI M=4 CASE - 11

PRIOR APOGEE FOR MAC

19792.09594	-93122.00000	1	-722726.4765	-1078.047851	1	.6476192474	53.90234375
-1.608005523	177.3810615	2	726795.1171	840.0772857	2	.0894610155	6.415063142
21798982.50	-25.89996504	3	58.17247581	25417.39038	3	76.46746444	89.92102622

18 MINUTES LATER

20872.09594	-92689.75000	1	-548433.6484	-783.8320312	1	-.1458929926	53.57739257
1.221330642	177.3810615	2	555090.0937	637.0195312	2	.0794579545	8.894635319
21822699.25	3.878993660	3	121.6263122	25396.69116	3	61.33528470	89.99717998

KENEHAN GEMINI M=4 CASE - 12

PRIOR APOGEE FOR MAC

19802.83984	-94185.25000	1	-696468.0781	-462.0595703	1	.9361474514	53.87402343
-1.117908477	260.4725494	2	700998.0781	809.7642898	2	.0406984794	6.809756577
21802665.00	-25.68406820	3	58.28763771	25413.83496	3	76.00300025	89.93344497

18 MINUTES LATER

20882.84008	-94269.25000	1	-520482.0781	-229.6660156	1	-1.242581784	54.19067382
.6772775650	260.4725494	2	527765.1640	603.7401351	2	.0238621728	9.608315825

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21820012.00	4.350084424	3	121.5431108	25400.40625	3	61.37778139	90.00767707

KENEHAN GEMINI M=4 CASE - 13

PRIOR APOGEE FOR MAC

19759.69091	-90345.50000	1	-714008.2187	-8238.992187	1	.1126518249	51.91210937
-11.91466522	108.0438833	2	717937.2734	829.1770706	2	.6907502636	6.294469356
21805353.00	-26.35251688	3	55.70557785	25412.04174	3	77.43502807	89.93075084

18 MINUTES LATER

20839.69091	-90759.25000	1	-544476.7812	-11386.37695	1	-.9467447102	52.59106445
5.988290786	108.0438833	2	550830.8046	631.4424514	2	1.189587041	8.771286129
21824048.00	2.889294147	3	119.5601682	25397.51489	3	61.23714113	90.00574779

KENEHAN GEMINI M=4 CASE - 14

PRIOR APOGEE FOR MAC

19736.62280	-92785.75000	1	-712815.6718	1028.763671	1	-.0429625511	53.45727539
-3.131217956	288.4577903	2	716858.3906	828.0738906	2	-.0760059785	6.503514587
21795400.75	-26.56027483	3	54.16986942	25420.87231	3	77.87798023	89.94185161

18 MINUTES LATER

20816.62304	-93215.25000	1	-538240.8671	-1367.021484	1	-.8130798936	54.12597656
-1.610547065	288.4577903	2	544947.3359	624.8829498	2	.1497889552	9.144676327
21813860.50	2.472817361	3	118.2748584	25406.74755	3	61.19180917	89.99562358

KENEHAN GEMINI M=4 CASE - 15

PRIOR APOGEE FOR MAC

19895.67236	-86843.75000	1	-712416.1171	-2060.039062	1	.4993739128	51.37963867
-3.393383026	188.0795478	2	714877.3359	828.9530563	2	.1742546633	6.044998049
21777225.50	-24.36930775	3	63.90684986	25449.63452	3	73.79497337	90.10828304

18 MINUTES LATER

20975.67236	-84939.50000	1	-548569.2265	-2600.855468	1	2.487555980	49.72119140
1.827462196	188.0795478	2	552151.9843	641.5601501	2	.2694944255	8.131409049

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21754974.25	6.892817556	3	126.6080198	25481.43798	3	61.85986280	89.97508239

STATISTICAL INFORMATION

PRIOR APOGEE FOR MAC

DIFFERENTIAL CYLINDRICAL COORDINATES

-92156.48242	-715059.5312	1	-1042.709197	.5731416195	1	53.33260059	-2.415128052
3081.974212	-19779700.75	2	-2524963.281	449.2144241	2	-4852.037597	574.0460205
-.6477426961	9908.049926	3	856556.3203	-2716.830169	3	10289.76928	-8100.175476
-.3761751540	.0396946319	4	2177.890075	237.2895832	4	1422.426620	4290.530334
.2221783958	-.4179760888	5	.1660809628	.6560287326	5	-.3445172496	.6360939368
-.9273630157	.6117473021	6	.3847233318	-.3093447313	6	1.697639152	-.1813840475
.0641084322	-.2813867777	7	.6780667752	.3337304517	7	-.0367748700	2.905377388

18 MINUTES LATER

DIFFERENTIAL CYLINDRICAL COORDINATES

-91727.25000	-542276.5156	1	-1450.992187	-.0309896469	1	53.11956357	.9388586432
3590.882354	-44131384.50	2	304306.3828	2779.504699	2	-7378.523681	3117.611938
-.8319188952	14772.88732	3	-6496298.250	-5403.298156	3	27132.58618	-9060.650390
.0296281585	-.1537429988	4	2860.258056	372.5997467	4	-404.0354423	-2977.394104
.5486718192	-.2592626586	5	.0923387008	1.410761415	5	-1.214787617	.2589709908
-.9771188646	.8733833432	6	-.0671727834	-.4094735756	6	2.102911025	-1.727301284
.4490659982	-.3172365986	7	-.5384190231	.0949482228	7	-.4248508513	1.933350965

SAMPLE MEAN

197.0003013	197.0003013	1			1		

SAMPLE VARIANCE

3369.433532	3369.433532	2			2		

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2. 4160-6023-RC000, "Error Analyses of the Gemini Mission Plan I, Revision I, and Plan II (U)", by B. H. Whalen and H. S. Weber, dated 11 January 1965.

3. 9882.5-5, "Orbit Control Logic Modifications for Gemini Error Analysis Task, Study 2", by M. F. Kenehan, dated April 27, 1965.

4. 4160-6003-RU-000, "Orbit Control Logic for the Gemini Simulation", by M. F. Kenehan, dated 1 August 1964.

5. 8655-6025-RU-000, "Technical Assistance in Support of Project Gemini - Vol. 1 Final Report", dated 1 May 1964.

6. FM6 Letter from NASA/MSC to P. N. Metzelaar specifying M =4 injection conditions, by H. W. Tindall, dated May 26, 1965.

7. MSC Internal Note No. 65-FM-19, "Project Gemini Proposed Nominal Trajectory Plan for the First Gemini-Agena Rendezvous Mission (GTA-6)",by K. A. Young and C. T. Osgood, dated 5 March 1965.

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11. 9882.5-10, "Telephone Conversation with R. Parten on 6/15/65 Re: RTCC Time Requirements for Determination of S/C Maneuvers",

12. 4160-6055-RU000, "Statistical Output Format Third Revision (SOPFMT III) ", by J. G. Harris, dated 24 May 1965.

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