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GT-12 POST FLIGHT ANALYSIS REPORT

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To: Gemini Program Mission Report
Gemini XII
MSC-G-R-67-1
By: Gemini XII Mission Evaluation Team
National Aeronautics and Space
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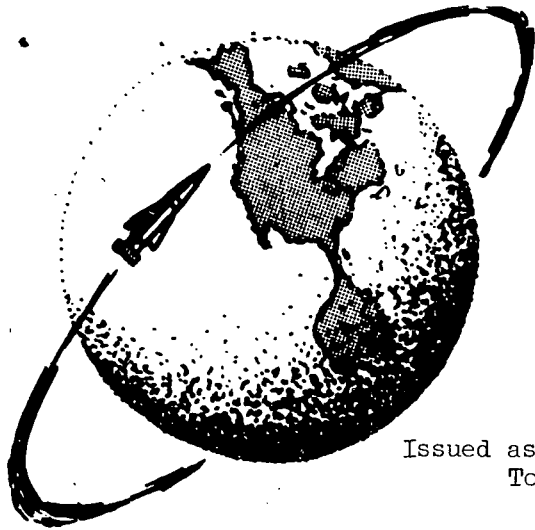
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GT-12 POST FLIGHT ANALYSIS
REPORT

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NASA GPO

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1.0 INTRODUCTION

Under NASA Contract No. NAS 9-6408, IBM performed a post flight analysis of certain aspects of the Gemini 12 mission. This report documents the work done and is intended as a supplement to the NASA Gemini Program Mission Report on Gemini 12.

By direction of the NASA GPO, IBM's efforts in the post flight analysis of the Gemini 12 mission were restricted to the accomplishment of three specific tasks, all associated with the rendezvous portion of the flight. These tasks were:

1. Reconstruct the flight trajectory from on-board radar and gimbal angle data. Such a reconstruction was to provide at least a good estimate of what the actual flight trajectory was as well as permit an assessment of the quality of the radar data gathered.
2. Use actual radar and gimbal angle data samples as inputs to a simulation of the rendezvous equations to see whether a closed-loop rendezvous solution could have been obtained if the computer had been left in the Rendezvous mode.
3. Reconstruct the flight trajectory (especially the final portion) from on-board accelerometer data, using the special integration program developed as part of the Gemini 10 analysis. If the results of this reconstruction appeared accurate, they were to be used as the basis for an analysis of the braking sequence.

The results of these analysis tasks as well as a description of the telemetry tape processing done for the Gemini 12 mission are discussed in the sections which follow.

2.0 CONCLUSIONS

During the early portions of the Gemini 12 flight the performance of the IGS was normal. In particular, the data supplied to the on-board computer by the spacecraft radar were free of unusual fluctuations and were of an accuracy comparable to that seen on previous flights.

Some time between 2:19:28 and 2:20:13 GET an anomaly occurred in the operation of the radar/computer system. It is likely that no radar ready signals were received by the computer in response to radar interrogation pulses until 2:32:01. It was not until 2:41:18 that the radar responded to two consecutive computer interrogations and a new set of radar data was accepted by the computer. As range to the target decreased, the frequency of radar response to computer interrogation increased. From 3:18:34 until lock-on was broken during station keeping the radar responded to every interrogation signal from the computer.

Range values obtained after 2:41:18 appeared to be as accurate as those received earlier, but corresponding angle data were noisy. Fluctuations in elevation appeared to be consistently greater than those in azimuth, with errors estimated to be as large as 8.8 degrees and 3.1 degrees for elevation and azimuth respectively. Although the data point to certain reasons for the behavior of the radar/computer system, the cause of the anomaly can not be determined from computer telemetry words alone.

Following the CDH maneuver, the computer was not put in the Rendezvous mode, as had been done on earlier flights, and, therefore, no closed-loop rendezvous solutions were obtained. Post-flight simulations show that closed-loop solutions could have been obtained approximately four minutes on either side of the flight TPI time but that no solution closer to the actual TPI time would have been possible. The rendezvous solutions obtained from the simulations appear to be reasonable, but a thorough analysis of their accuracy has not been attempted.

Two attempts were made to reconstruct the flight trajectory from spacecraft accelerometer data. For neither attempt were the results sufficiently accurate to serve as a basis for an analysis of the braking sequence, and no such analysis was attempted.

3.0 RENDEZVOUS ANALYSIS

3.1 Radar Trajectory Reconstruction

A special program, developed during the GT-11 analysis, was used to reconstruct the flight trajectory from on-board radar data. This program searches the spacecraft telemetry for changes in the radar data. When a change is detected, the three radar parameters (range, azimuth and elevation) and the three gimbal angles from the IMU are put through a set of equations which compute the position of the spacecraft in target-centered curvilinear co-ordinates.

The results of this reconstruction are presented graphically in the three parts of Figure 3-1. The first part of the figure shows data points plotted at sixty-second intervals over the period extending from just prior to the CSI maneuver to station keeping. The second part of the figure shows points plotted at thirty-second intervals, beginning with the first radar sample obtained after the CDH maneuver. Data points plotted at ten-second intervals over the period of the braking sequence are shown in the final portion of the figure. Because of the confused picture presented by the actual data points, especially those showing lateral displacement, an estimate of the true trajectory has been included in the third portion.

In addition to the reconstruction of the flight trajectory, an analysis of the radar data was performed. The salient points revealed by this analysis are tabulated in Table 3-1. As the table shows, radar lock-on was established at 1:23:45 GET and remained solid for the next 56 minutes. During this interval the quality of the data recorded was comparable to that seen on previous flights.

At 2:19:28 GET, with the computer in the Rendezvous mode, a radar sample was taken. Had the computer remained in the Rendezvous mode, a new sample would not have appeared in the on-board computer telemetry words until 2:20:28 GET. However, at 2:20:13 GET the computer was switched to the Catch-Up mode. Since the radar parameters which appear in the computer telemetry words are updated every computation cycle when the computer is in the Catch-Up mode, an immediate change in values of the radar data should have occurred. In actual fact, though, a change in telemetered radar did not occur until 2:41:18 GET, an interval of more than 21 minutes.

During the interval from 2:41:18 GET to 3:18:34 GET, radar lock-on changed gradually from sporadic to solid. From 3:18:34 GET until 3:45:22 GET, when lock-on was broken during station keeping, no loss of lock-on occurred. However, the data taken during this interval was poorer in quality than that taken earlier in the flight. Although the range data were smooth and reasonable, angle data were noisy, with estimated errors as high as 8.8 degrees in elevation and 3.1 degrees in azimuth. In general the error in elevation was larger than the error in azimuth.

The on-board computer telemetry words do not permit determination of the exact time of the loss of radar contact. Neither do they give any clue as to why contact was lost. It can only be determined that some time during the 45 seconds between 2:19:28 and 2:20:13 the computer stopped accepting radar data. Since the attitude of the spacecraft changed very little from 2:19:28 to 2:20:13 and the radar parameters were well within acceptable operating ranges throughout this interval, it can definitely be stated that lock-on was not broken by spacecraft maneuvering.

Computer flow tags, which appear in the computer telemetry words, can be used to gain a general, if not exact, idea of the logical paths being followed in the computer program. In a four-minute period early in the flight, when the computer was in the Catch-Up mode and the radar was working properly, 25 of the 100 flow tags in the telemetry words belonged to a group of four which indicate that the computer has sensed a radar ready pulse and has shifted in radar data. However, in the twelve minutes (300 telemetry samples) from 2:20:00 to 2:32:00 GET, none of the flow tags in that same group appeared at all, and in the next nine minutes (225 more telemetry samples) flow tags from that group appeared only a total of fourteen times. In that same 21-minute period, however, a single flow tag which indicates that the radar is being interrogated by the computer appeared 35 times.

From all of these facts, a likely picture of the operation of the radar/computer system during the interval from 2:19:28 to rendezvous can be drawn. Some time between 2:19:28 and 2:20:13 the radar ceased to respond with radar ready signals when interrogated by the computer. For approximately twelve minutes the computer received no response from the radar. During the next nine minutes occasional responses were received, but the radar never responded to two consecutive interrogations by the computer, a necessary condition for the computer's acceptance of radar data. Finally, at 2:41:18 the radar responded

to two consecutive interrogations and the computer accepted a new set of radar data. As range to the target decreased, the frequency of radar response to computer interrogation increased. By 3:18:34 the radar was responding to every interrogation signal from the computer, and this condition continued until lock-on was broken at 3:45:22 during station keeping.

The spacecraft radar provides three inputs to the on-board computer: range, azimuth, and elevation. When a signal pulse from the transponder in the target vehicle reaches the spacecraft radar, the leading edge turns off a 10 MHz digital range counter. Azimuth information is extracted from the middle portion of the signal pulse, and the elevation angle is determined from the latter portion of the pulse. As was mentioned previously, the values of range received after the re-establishment of radar contact appeared to be correct. The angle values, however, were noisy, and the errors appeared to be greater in the elevation angle than in the azimuth angle.

Radar operation of this character could have been caused by a sudden decrease in the strength and duration of the transponder signal pulses or by a sudden degradation in the performance of the radar detection circuits to the point that they were unable to sense normal transponder signals. This is only supposition, however, since the computer telemetry words do not contain enough data to permit a determination of the cause of the problem.

3.2 Rendezvous Solutions Using Flight Data

During the Gemini 12 rendezvous sequence, because of the problems concerning radar lock-on, the on-board computer was not put in the Rendezvous mode, as would normally have been done, but rather was left in the Catch-Up mode most of the time. This meant that no closed-loop rendezvous solutions were obtained from the IGS. When examination of the radar data accepted by the computer during the interval from CDH through TPF revealed the possibility that closed-loop solutions could have been obtained, it was decided to determine what, if any, closed-loop solutions would have resulted if the computer had been placed in the Rendezvous mode and left there.

The computer program used for this investigation was the IBM static FORTRAN Module III simulator. The simulations were run as though the computer had been switched into

the Rendezvous mode and a radar time hack established at 2:40:15 GET. Radar samples which would have been accepted for use in the rendezvous equations were determined by visual inspection of the telemetry data. These sets of radar values, along with the corresponding sets of gimbal angles, were provided as inputs to the simulator in the proper time sequence. Control was exercised, through inhibiting of the simulated radar ready signal, to insure that the proper radar samples would be "missing" and that those samples which were accepted would have the correct amount of "lateness".

The results of the investigation showed that no closed-loop solution would have been possible for the time at which the rendezvous sequence was initiated in the Gemini 12 flight. The midpoint of the flight TPI maneuver came at 3:06:02 GET. A radar sample would have been required at 3:02:02 GET in order to produce a closed-loop TPI solution at that time. However, telemetry data reveal that no radar samples were accepted by the computer from 2:57:35 to 3:05:35.

Although there could not have been a closed-loop solution at the time of the flight maneuver, solutions would have been possible both before and after that time. To investigate the possibilities of these solutions, two simulations were run of the complete set of three closed-loop maneuvers in the rendezvous sequence: terminal phase initiate (TPI), first midcourse correction (COR_1), and second midcourse correction (COR_2). The first case simulated used the 2:57:35 radar sample as the last pre-TPI data point. The second case was based on the radar sample taken at 3:05:35. Tables 3-2 and 3-3 show the data which were used in the closed-loop calculations for the two cases simulated, and the results obtained are tabulated in Table 3-4.

When the results of the two simulations are compared with the flight values, the simulator solutions for TPI appear reasonable. The three TPI maneuvers produce approximately the same altitude change, and the amount of downrange adjustment produced decreases as range to the target decreases, as would be expected.

The data inputs to the simulations were the actual flight data samples, taken from a trajectory intended to intercept the target at 3:38:32. However, the simulations were seeking to produce intercept at 3:34:07 and 3:42:07 for cases 1 and 2 respectively. Thus the data told the simulator that intercept would

occur four and one-half minutes too late in case 1 and three and one-half minutes too early in case 2. When these facts are taken into account, the simulation results for the mid-course maneuvers also appear reasonable.

It is certain that the erratic behavior of the radar angles during the rendezvous portion of the Gemini 12 flight would have produced error in the closed-loop calculations, and no attempt has been made to determine how large this error would have been. However, from the results of the simulations performed it is also certain that closed-loop solutions could have been obtained. For this reason it is recommended that if a similar situation arises during a future program, the closed-loop system be permitted to continue to function. The crew may decide not to use the closed-loop results, but at least they will have one more source of information to aid them in their choice.

3.3 Flight Trajectory Reconstruction from Accelerometer Data

An attempt was made to reconstruct the flight trajectory from on-board accelerometer data, using the special integration program developed as part of the Gemini 10 analysis. This program integrates trajectories for both the target and spacecraft, starting from an initial set of state vectors which is supplied as input. Spacecraft accelerations as recorded in the computer telemetry words are used as thrust terms in the integration of the spacecraft orbit. The output of the program includes time histories of: the components of the spacecraft state vector in target-centered curvilinear co-ordinates, the azimuth and elevation turning rates of the inertial line of sight to the target, range to the target, and range rate.

The reconstruction was run from a set of state vectors provided by TRW (see Table 3-5). The values of the nine terms of the accelerometer misalignment and scale factor matrix and the three accelerometer biases which were in the computer at launch were used in the reconstruction, and no platform misalignments were simulated. Table 3-7 shows the components of the spacecraft position in target-centered curvilinear co-ordinates obtained from the program for times following each of the five maneuvers of the rendezvous sequence as well as the start of station keeping. The corresponding points from the reconstructed radar trajectory are included in the table for comparison.

When it was discovered that the reconstructed flight trajectory and the radar trajectory differed to so large a degree, the reconstruction was run again using the state vectors tabulated in Table 3-6 which were obtained from NASA. The results of this second run, included in Table 3-7, were not significantly better than those obtained from the TRW state vectors.

Although it was realized that the noisy radar angles produced sizeable errors in the radar trajectory, it was felt that there should be a closer agreement between the radar trajectory and the reconstructed flight trajectory than had been obtained. For this reason it was felt that neither flight trajectory reconstruction was accurate enough to serve as a basis for an analysis of the braking sequence and no such analysis was attempted.

TABLE 3-1

RADAR DATA HISTORY

<u>GET</u> hr:min:sec	<u>EVENT</u>	<u>COMMENTS</u>
1:23:45	Radar lock-on established.	Data appear good. Only small fluctuations in angles. Lock-on solid with no breaks.
1:50:25	Computer switched to Rendezvous mode.	Data still good.
1:50:28	First radar sample for rendezvous calculations taken.	Samples taken at one-minute intervals for next 29 minutes. No lateness noted in sample times. Data appear good. No loss of lock-on noted.
2:19:28	Thirtieth radar sample for rendezvous calculations taken.	Spacecraft in approximate attitude for CDH maneuver. Data still good.
2:20:13	Computer switched to Catch-Up mode.	Loss of lock-on noted in telemetry data for first time. No new radar data being accepted by computer.
2:41:18	First radar data since 2:19:28 accepted by computer.	Intermittent lock-on established. Quality of lock-on improves steadily over next 37 minutes. Range data good, angle data noisy. Elevation angle worse than azimuth.
3:18:34	Last evidence of loss of lock-on.	Lock-on solid from this time on. Quality of data unchanged: range good, angles noisy, elevation worse than azimuth.
3:45:22	Station keeping.	Range = 49 ft. Lock-on broken at this time.

TABLE 3-2

FLIGHT DATA FOR RENDEZVOUS EQUATIONS

CASE 1

Radar Point	GET ^b hr:min:sec	Pitch deg.	Yaw deg.	Roll deg.	Range feet	Elevation deg.	Azimuth deg.	Lateness ^b sec.
1	2:48:05.8	14.09	0.72	1.90	234,677	-0.83	-1.91	50.05
2	Missing							
3	Missing							
4	Missing							
5	2:51:46.6	15.37	0.50	0.90	212,596	1.71	-0.14	31.00
6	2:52:15.4	15.95	0.64	2.56	210,138	0.57	0.67	0.07
7	2:53:49.0	16.67	0.54	0.65	200,745	1.92	-1.19	33.02
8a	2:54:44.2	17.32	0.78	-1.16	195,827	-2.43	-0.48	29.05
9a	2:55:17.8	17.32	0.61	-0.65	192,679	2.49	0.19	2.00
10a	Missing							
TPI	2:57:34.6	19.03	0.48	-1.29	179,401	-2.49	-2.62	19.07
1	3:05:34.5	26.59	0.03	-2.69	133,666	2.33	0.72	0.12
2	Missing							
3	3:06:22.5	29.58	1.26	-4.12	128,896	0.83	-1.72	6.97
4	Missing							
5	3:06:58.5	28.43	0.20	5.29	124,912	0.00	-0.91	3.92
6	Missing							
7	3:07:51.3	30.12	-0.14	0.39	118,912	0.93	0.38	17.12
COR1	3:13:34.4	39.85	-0.14	0.72	82,127	1.35	1.14	0.09
1	3:17:34.4	50.80	0.84	-2.14	59,702	-3.57	0.95	0.11
2	3:17:56.0	49.79	-0.72	0.76	57,932	-4.92	0.67	1.98
3	3:18:15.2	50.54	-0.90	1.12	56,407	-5.76	1.29	1.08
4	3:18:34.4	51.16	-0.68	-0.43	54,686	0.78	0.76	0.06
5	3:18:56.0	52.20	-0.68	-0.14	52,916	-1.55	-1.95	1.93
6	3:19:15.2	52.94	-0.70	1.25	51,440	-4.98	-3.96	0.91
7	3:19:34.4	53.71	-0.94	0.47	49,916	-7.89	-3.77	0.01
COR2	3:25:34.4	72.54	-1.19	1.58	26,605	0.10	-2.86	0.15

NOTES:

- Samples 8, 9 and 10 of an 11-sample data set are not used in the rendezvous calculations.
- GET values shown are telemetry sample times. Latenesses shown are based on simulated radar sample times and are not generally compatible with telemetry sample times.

TABLE 3-3

FLIGHT DATA FOR RENDEZVOUS EQUATIONS
CASE 2

Radar Point	GET ^b hr:min:sec	Pitch deg.	Yaw deg.	Roll deg.	Range feet	Elevation deg.	Azimuth deg.	Lateness ^b sec.
1	2:55:17.8	17.32	0.61	-0.65	192,679	2.49	0.19	2.00
2	Missing							
3	2:57:34.6	19.03	0.48	-1.29	179,401	-2.49	-2.62	19.07
4	Missing							
5	Missing							
6	Missing							
7	Missing							
8a	Missing							
9a	Missing							
10a	Missing							
TPI	3:05:34.5	26.59	0.03	-2.69	133,666	2.33	0.72	19.09
1	3:13:34.4	39.85	-0.14	0.72	82,127	1.35	1.14	0.12
2	3:13:56.0	40.19	-0.30	0.59	79,963	-0.78	-3.48	1.99
3	3:14:15.2	40.89	-0.38	0.74	78,045	-4.15	-6.45	0.97
4	3:14:36.8	41.87	-0.52	-0.17	75,882	-7.22	-5.20	1.92
5	3:15:03.2	42.66	-0.50	0.76	73,324	1.19	1.57	8.89
6	3:15:17.6	43.42	-0.54	-0.04	72,144	0.00	0.81	2.89
7	3:15:34.4	44.14	-0.54	0.00	70,325	-1.14	-0.24	0.09
COR ₁	3:21:34.4	59.18	-1.45	0.91	41,162	-0.62	-1.48	0.11
1	3:25:34.4	72.54	-1.19	1.58	26,605	0.10	-2.86	0.01
2	3:25:56.0	73.84	-1.51	-1.15	25,474	-1.92	-0.86	0.96
3	3:26:15.2	75.46	-1.12	-0.14	24,540	-0.93	-3.00	0.98
4	3:26:34.4	76.60	-1.73	1.11	23,605	-1.81	-2.96	0.08
5	3:26:56.0	78.00	-1.47	-0.19	22,573	1.86	-2.77	0.91
6	3:27:15.1	79.15	-1.42	-0.28	21,638	2.38	-4.68	1.06
7	3:27:34.3	80.26	-1.56	0.14	20,753	-4.61	-1.72	0.03
COR ₂	3:33:34.3	104.76	-0.97	2.16	8,606	0.16	-2.15	0.05

NOTES:

- a. Samples 8, 9 and 10 of an 11-sample data set are not used in the rendezvous calculations.
 b. GET values shown are telemetry sample times. Latenesses shown are based on simulated radar sample times and are not generally compatible with telemetry sample times.

TABLE 3-4
SIMULATED CLOSED-LOOP RENDEZVOUS SOLUTIONS
USING ACTUAL FLIGHT INPUT DATA

		CASE 1		CASE 2	
		Navigational Co-ordinates	Spacecraft Co-ordinates	Navigational Co-ordinates	Spacecraft Co-ordinates
TPI	GET	3:01:35		3:09:35	
	Point Pairs	4		2	
	ΔV_t	81.2		45.4	
	ΔV_x	8.6	22.3	18.8	18.3
	ΔV_y	-43.5	- 1.9	- 3.4	- 8.4
	ΔV_z	2.6	-38.4	8.1	5.0
COR ₁	GET	3:13:35		3:21:35	
	Point Pairs	4		7	
	ΔV_x	3.2	2.3	2.1	- 2.4
	ΔV_y	0.2	- 8.7	4.2	- 4.0
	ΔV_z	8.7	2.3	4.0	4.1
COR ₂	GET	3:25:35		3:33:35	
	Point Pairs	7		7	
	ΔV_x	14.0	13.0	5.3	- 8.5
	ΔV_y	- 9.2	2.7	7.5	- 0.6
	ΔV_z	- 2.1	10.5	0.6	3.2

NOTE: Actual flight TPI: $\Delta V_x = 19.4$, $\Delta V_y = -10.1$, $\Delta V_z = 0.5$ (navigational co-ordinates) applied from 3:05:47 to 3:06:18 GET.

TABLE 3-5

TRW STATE VECTORS

GATV 12

GMT = 11 November 19 hours 17 minutes 24.00 seconds
 X = +0.36267674 E+7 ft.
 Y = -0.18930400 E+8 ft.
 Z = +0.10378403 E+8 ft.
 \dot{X} = +0.25016516 E+5 fps.
 \dot{Y} = +0.35245391 E+4 fps.
 \dot{Z} = -0.22718317 E+4 fps.

Gemini 12

GMT = 11 November 23 hours 52 minutes 20.72 seconds
 X = +0.91213528 E+7 ft.
 Y = -0.17481891 E+8 ft.
 Z = +0.93761780 E+7 ft.
 \dot{X} = +0.23075254 E+5 fps.
 \dot{Y} = +0.90196660 E+4 fps.
 \dot{Z} = -0.55894848 E+4 fps.

Cartesian co-ordinates
 Aries reference frame

TABLE 3-6

NASA STATE VECTORS

GATV 12

GMT	=	11 November 23 hours 36 minutes 33.0 seconds
X	=	-0.20115474 E+8 ft.
Y	=	+0.57074091 E+6 ft.
Z	=	+0.85874106 E+7 ft.
\dot{X}	=	+0.23461367 E+4 fps.
\dot{Y}	=	-0.24244541 E+5 fps.
\dot{Z}	=	+0.71371738 E+4 fps.

Gemini 12

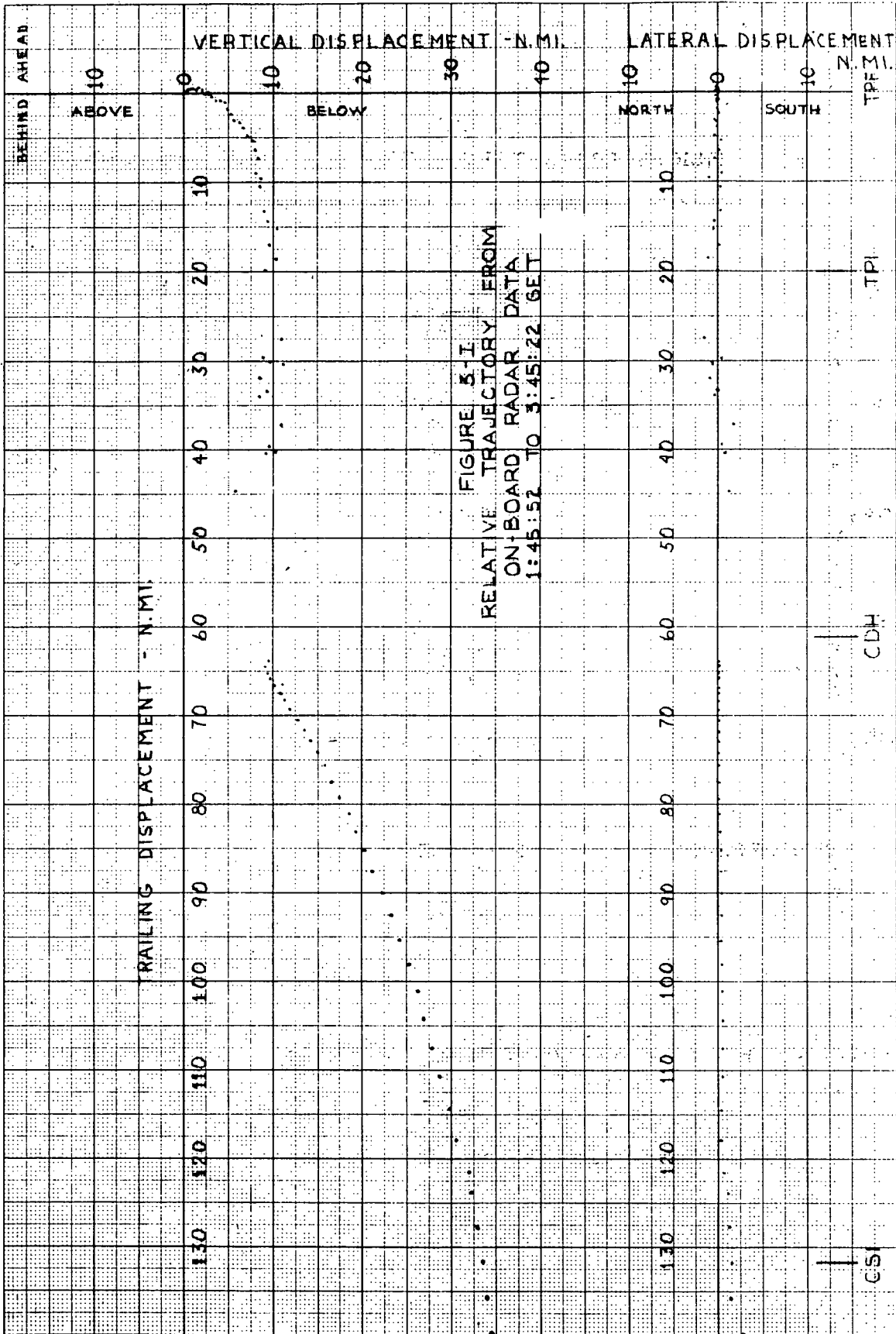
GMT	=	11 November 23 hours 36 minutes 33.0 seconds
X	=	-0.20082461 E+8 ft.
Y	=	+0.77655726 E+6 ft.
Z	=	+0.85012704 E+7 ft.
\dot{X}	=	+0.21208737 E+4 fps.
\dot{Y}	=	-0.24266927 E+5 fps.
\dot{Z}	=	+0.72462632 E+4 fps.

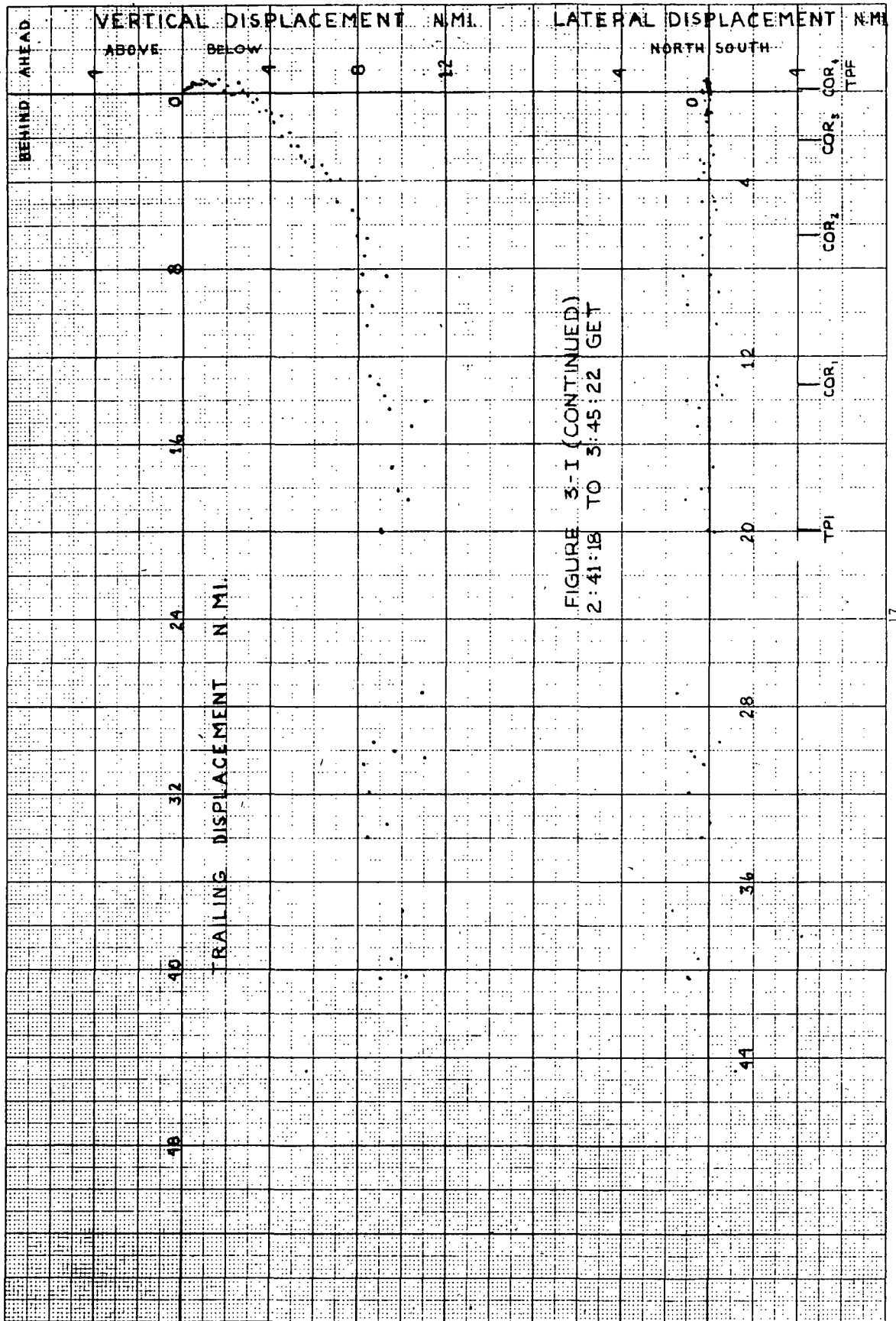
Cartesian co-ordinates
Greenwich reference frame

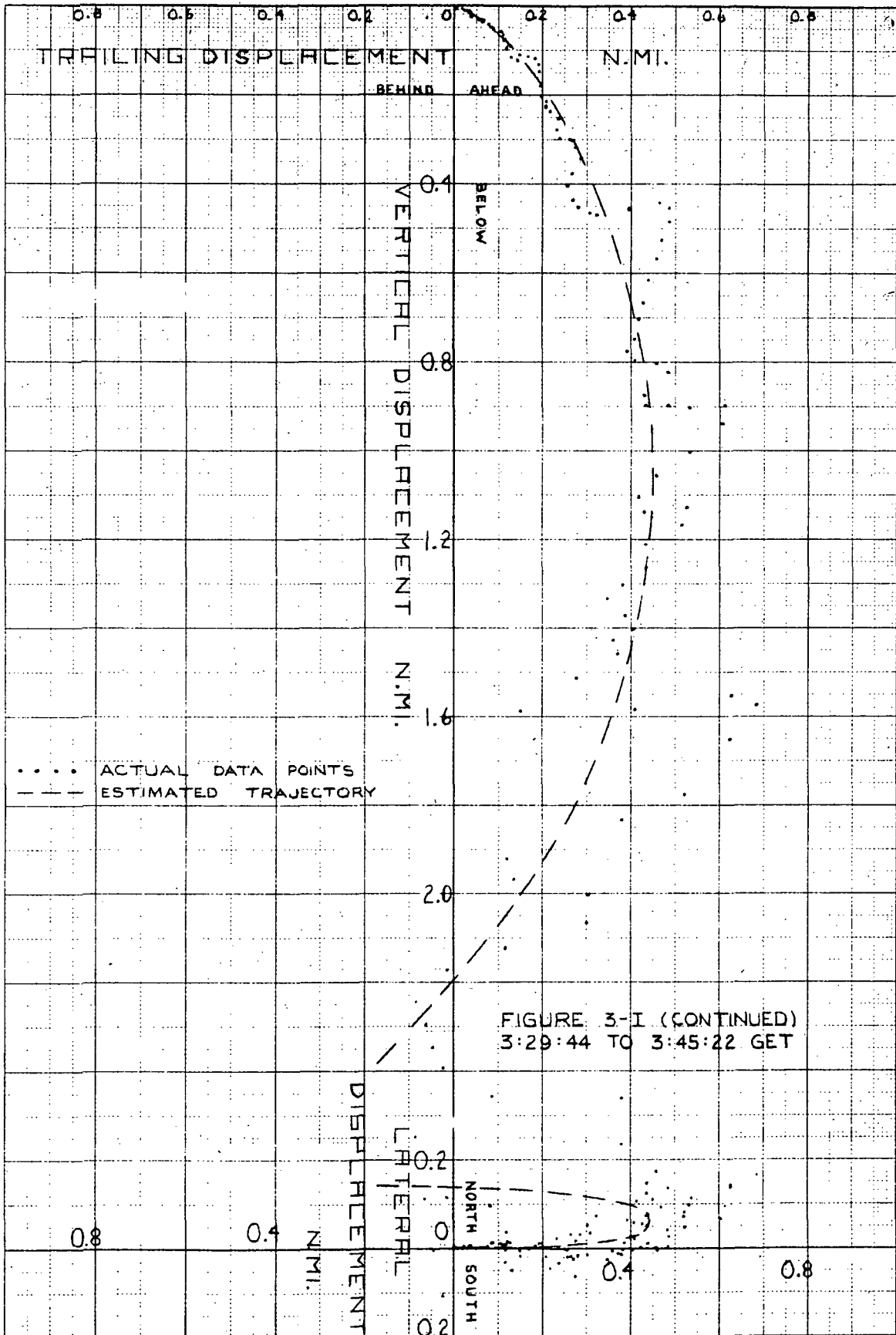
TABLE 3-7
FLIGHT TRAJECTORY RECONSTRUCTION RESULTS

	<u>TRW</u>	<u>NASA</u>	<u>Radar</u>
TPI	3:06:22.5 GET		
X	110,983	114,283	112,712
Y	- 61,474	- 62,822	- 62,449
Z	435	1,075	6,811
COR ₁	3:11:36.9 GET		
X	72,598	74,439	78,587
Y	- 56,546	- 58,595	- 52,071
Z	177	2,109	- 2,411
COR ₂	3:17:15.2 GET		
X	37,223	37,092	38,216
Y	- 46,699	- 49,042	- 47,982
Z	- 115	2,918	- 1,093
COR ₃	3:23:51.2 GET		
X	8,115	5,668	12,250
Y	- 31,170	- 33,203	- 30,060
Z	- 374	3,352	102
COR ₄	3:29:10.3 GET		
X	- 4,912	- 8,817	- 889
Y	- 18,368	- 19,678	- 16,457
Z	- 292	3,430	2,160
STATION KEEPING	3:45:22.3 GET		
X	- 10,211	- 13,820	- 44
Y	- 1,862	379	- 20
Z	- 785	166	9

Values shown are in target-centered curvilinear co-ordinates and are expressed in feet.







4.0 TELEMETRY TAPE PROCESSING

A total of seven tapes of on-board computer telemetry words were processed by IBM as part of the GT-12 post flight activity. Table 4-1 lists both the seven tapes which were received and the processed tapes which were shipped to various organizations.

The general procedure used in processing telemetry tapes is as follows:

1. The input tapes are put through a pre-processing program which reformats the data for use with other programs.
2. The pre-processed tapes are fed to the Data Reduction Compiler (DRC) program which time tags the individual quantities. The Gemini telemetry system takes frames of twenty-one computer words at 2.4 second intervals. Since the computer and the telemetry system run asynchronously, it is generally true that the telemetry frames are taken when the computer is part way through a computation cycle. Therefore, some of the quantities in the frame have been updated during the cycle in which the frame is taken and others remain at the values computed during the previous computation cycle. Time tagging associates the time of the proper computation cycle with each quantity in the frame.
3. The output of the DRC program is used as input to the Time Align program. In general, each of the quantities in a telemetry frame is computed at a different time. The Time Align program adjusts the various quantities to the values they would have had if they had all been computed at the same time. For Ascent and Reentry data, the quantities are adjusted to the times the accelerometer are read. Catch-Up and Rendezvous quantities are adjusted to radar interrogation times.
4. The output of the Time Align program is visually inspected to detect records which, due to partial telemetry dropouts, noise or other similar reasons, contain data which are obviously incorrect. These records are edited from the tapes by further passes through the Time Align program.

5. The final edited data tapes are then copied, and the tape copies and/or tape listings are shipped to the proper organizations.

The first six tapes listed in Table 4-1 were sent from NASA and were started through the entire process outlined above. During this operation, it was discovered that the data contained on the first two tapes was offset due to an erroneous word in position 1 of each record. This was corrected by a program change and further processing continued without any problems.

The ascent portion of the flight was delivered on two tapes. The first tape contained Pre-liftoff and Post-liftoff data thru 426 secs. The second tape contained data covering 426 secs. thru 563 secs. after liftoff.

The five input tapes containing data from the Catch-Up and Rendezvous modes were put through the initial pass of the outlined process when word was received to terminate the Tape Copy operations. Therefore, no shipments were made of these tapes. Some further processing was necessary to support the Post Flight reconstruction.

The Reentry tape was sent from McDonnell Corporation. Since the data on this tape had already been time tagged, the pre-processing and DRC passes were not necessary. This tape was processed and delivered with no trouble.

TABLE 4-1
TELEMETRY TAPE PROCESSING SUMMARY

Input Tapes	Date Received	Output Tapes	Date Shipped	Recipients	Comments
Ascent	11/15/66	Ascent Pre-liftoff/Post-liftoff (2 files)	11/18/66	NASA, TRW Systems, Martin-Marietta, Aerospace, McDonnell*	Input data words shifted by one word. Program change to correct.
Ascent/Rev 1	11/15/66	Ascent 426-563 secs.	11/21/66	Same as above	Same as above
Rev 2, 3, 4, 5 and Rev 2 Real Time	11/18/66	Raw pass was completed on all tapes when word was received to terminate the tape processing portion of the GT-12 post flight analysis. Therefore, no shipments of these runs were made.			
Reentry	11/21/66	Reentry	11/22/66	NASA, TRW Systems, McDonnell*	

*McDonnell Corporation sent tape listing only. Tapes and listings sent all others.