

STS-4 GNC Postflight Report

The enclosed STS-4 GNC postflight report is limited in scope to analysis of systems anomalies and discussion of topics which we believe need attention.

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1.1 TACAN

1.1.1 Preflight Self-Test - during the L-1 day crew briefing, we were informed of a number of TACAN anomalies which were discovered during nav aid self-test (L-72 hrs).

a. Following a successful self-test, TACAN #1 failed to lock onto the KSC TACAN station 059Y when its rotary switch was returned from the GPC to the T/R position. A repeat of this operation, including another self-test, resulted in a successful lock onto 059Y. This procedure was repeated 10 times in an attempt to duplicate the anomaly, but with no success. There is, as yet, no explanation for this anomaly; however, E&D personnel feel that the LRU was not at fault, in as much as it exhibited normal search characteristics during the anomalous period and subsequently behaved normally during further testing. This would suggest that the LRU never received a command to search for 059Y, although telemetry suggested otherwise. In the VAB a spectrum analyzer could have determined what frequency the TACAN was outputting, but unfortunately this was not feasible on the pad. (IPR 4V-535 was written against this unit).

b. During one of the ten subsequent self-tests, the T/R bit in the control word dropped to the "0" state when moving from T/R to GPC with TACAN #1 rotary switch. This condition was duplicatable by slowly rotating from T/R to GPC, much slower than normal rotation rate. The following explanation suggests this is not an anomaly, but rather an unlikely condition, and one that has no impact to system operation. When in the GPC position the MDM will command the TACAN to the word coming from the GPC (completely disregards the current control panel inputs). However, if the SOP is inactive and no new command word is coming from the GPC (which is the condition we were in), then the MDM will revert back to the last command it had received from the control panel (just prior to receiving the GPC position indication). In the case where the rotary slowly moves from T/R to GPC position, it is possible that the +5V signal representing T/R could drop to a "0" state (detectable by the MDM) before the GPC position indication is sensed by the MDM, thus representing the receive position. This situation has no real impact to the TACAN system operation since the T/R bit will return to the "1" state when the TACAN SOP becomes active.

c. During another of the 10 self-tests, TACAN #2 range output a value of 296.14 NM, where an acceptable value is between "0.0 and 0.5 NM." This anomaly did not repeat itself on any of the subsequent tests. E&D has suggested the following scenario, which might have created this condition, but would be near impossible to duplicate statistically. Bearing data is updated within the TACAN output buffer on a cyclic basis; however, range data is updated only after a change in computed range of greater than 0.05 NM. If the first valid range (following the random search value of 296.14 NM) of data reached the output buffer a few micro-seconds behind a bearing update, it is possible that no range update took place. And if subsequent data out of the range computation circuitry remained within 0.05 NM of the previous valid range output, then no attempt to further update the output buffer would occur, thus freezing the range test value at 296.14 NM. This condition has never been recorded as a self-test anomaly (within our failure history reports), representing an obviously rare, however feasible situation. (IPR 4V-539 was written against this unit).

1.1.2 Bearing Oscillation - following many hours of lock-on to the channel Q59Y KSC ground station (approximately 24 hrs), TACAN #2 bearing began to exhibit random fluctuation around the correct value. KSC explained this phenomenon as the effects of tanking operations in the vicinity of the TACAN #2 antenna, causing multipath problems. However, a few hours later this fluctuation became cyclic, repeating every 7-8 seconds, with a total variation of approximately ± 20 degrees. We recommended a special TACAN self-test, but KSC disagreed, as their criteria for an acceptable LRU (Successful self-test at L-72 hrs and subsequent power status) was not being violated. A plot of bearing data during the 70 seconds of ascent lock-on suggests that the oscillations were present and would very likely have been declared failed by RM, had it been active during that period. Although KSC insisted this phenomenon is similar to data seen on previous missions (multipath effects due to environmental conditions, structural reflections, etc.), both E&D and the TACAN vendor are of the opinion that an anomaly existed. E&D will recommend removal of TACAN #2 for test and analysis, although no failure reports were generated by KSC. Subsequent operation of this unit during the flight (including self-test, on-orbit tracking, and entry) showed no evidence of the preflight anomaly, albeit the longest period of operation did not exceed 5-6 hrs.

NO. STS 004

FOD STS PROBLEM ENTRY FORM (PAGE 1)

DATE FILED

06/27/82

CLOSED 1-1-1

MISSION(3)

VEHICLE(7)

DISCIPLINE(10)

REV ---

STS 004

OV-102

GNC/NSRS

1-1-1

SUBSYSTEM(20)

GNC

MAJOR COMPONENT(15)

TACAN

MINOR COMPONENT(15)

SERIAL NUMBER(20)

TACAN - S/N 34

CONTACT: FOD-

ED LIEBMAN

E&D-

DON RHOADES

MAILCODE/PHONE

CF6/5595

RIC-

OTHER-

PROBLEM IDENT:

CAUSE(8)

HDW

FAIL MODE(12)

CYCLIC DATA

MISSION PHASE(12)

PRE-LAUNCH

GMT OCCURRED

~178:10:00:00

GMT RECOGNIZED

178:10:20:00

PROBLEM DESCRIPTION:(1092)

Following many hours of lock-on to channel 059Y ground station, TACAN #2 Bearing began to exhibit random fluctuations around the correct value. RSC explained this phenomenon as the effects of tanking operations in the vicinity of TACAN #2 Antenna, causing multi-path problems. A few hours later this fluctuation became cyclic, repeating every 7-8 seconds with a total variation of $\pm 20^\circ$ around the actual

FOD STS PROBLEM ENTRY FORM (PAGE 2)

PROBLEM RESOLUTION: (1092)

- HARDWARE/SOFTWARE FIX
 FLY AS-IS
 PROCEDURAL WORK AROUND
 SMS CHANGE RPT
 COMPLETED (SMS)

We recommended a special TACAN Self-Test, but RSC disagreed; their criteria for an acceptable LRF is a successful selftest (at T-2 days 6 hrs) and subsequent good power status.

A TACAN Self-Test is scheduled on-orbit.

REMARKS: (160)

HARDWARE IDENTIFICATION:
 SYSTEM/COMPONENT
 NEXT HIGHER ASSEMBLY

PART NAME
TACAN

PART NUMBER

SYSTEM/COMPONENT
 NEXT HIGHER ASSEMBLY

MANUFACTURER
GOULD

SERIAL/LOT
34

PROBLEM EFFECTIVITY:

VEHICLE NUMBER OV-102 OV-099
 MISSION NUMBER STS =4 STS STS

ATTACHED DATA: (110)

REFERENCES: (110)

- 1.2 IMU 3 Cage Fail - the azimuth gimbal of IMU 3 did not drive to the zero position in response to the operate command. Preflight alignment performance was normal. It was determined that all of the possible failure points that would produce a cage fail, but permit preflight align would not affect operation of the IMU. Unless testing planned by E&D and KSC to locate the failure turns up new concern for significantly increased risk of further related failures affecting operation, we recommend flying this IMU again as is.

NO. STS _____ FOD STS PROBLEM ENTRY FORM (PAGE 1) DATE FILED 06/27/82
 CLOSED 1-1-1
 MISSION(3) _____ VEHICLE(7) OV-102 DISCIPLINE(10) GNC/SNRS REV. _____
 STS -004 MAJOR COMPONENT(15) IMU
 SUBSYSTEM(20) GNC
 MINOR COMPONENT(15) CAGING CIRCUITRY SERIAL NUMBER(20) IMU #3=#16
 CONTACT: FOD- ED LIEBMAN E&D- STAN BACHMAN
 MAILCODE/PHONE CE6/5595
 RIC- _____ OTHER- _____
 MAILCODE/PHONE _____
 PROBLEM IDENT:
 CAUSE(8) HDW FAIL MODE(12) FAILS OPEN
 MISSION PHASE(12) PRE-LAUNCH GMT OCCURRED 178:06:53:00 GMT RECOGNIZED 178:08:20:00

PROBLEM DESCRIPTION(1092):

When the operate command was sent to the IMU's, all gimbals moved to their zero degrees "caged" position except for the IMU#3 Azimuth, which rested at approximately 138 degrees. As data was not available prior to this time, it is not known what angle that gimbal read prior to the operate command. On the assumption that no gimbal movement occurred, it would appear that a relay did not close thereby preventing the zero degree caging command from reaching the Azimuth caging motor (Relay in question is used only during caging operations).

PROBLEM RESOLUTIONS: (1092)

- HARDWARE/SOFTWARE FIX FLY AS-IS PROCEDURAL WORK AROUND SMS CHANGE R
 COMPLETED (SMS)

No impact due to caging of Azimuth gimbal to non-zero angle, since all gimbals are then repositioned to desired angles prior to re-instating into usable set.

REMARKS: (160)

HARDWARE IDENTIFICATION:

SYSTEM/COMPONENT
NEXT HIGHER ASSEMBLY

PART NAME

IMU

PART NUMBER

MANUFACTURER

SINGER

SERIAL/LOT

#16

SYSTEM/COMPONENT
NEXT HIGHER ASSEMBLY

PROBLEM EFFECTIVITY:

VEHICLE NUMBER

OV-102

OV-099

MISSION NUMBER

STS = 8 ---

STS ---

STS ---

ATTACHED DATA: (110)

REFERENCES: (110)

1.3 DAP Auto PBI Contact RM Fail - the forward, orbital DAP, auto control mode PBI (panel C3A6, switch 3) contact A (V72K2840X) failed RM while the crew was expanding from a single G2 GPC to a dual G2 GPC redundant set. The PBI was depressed and held during the expansion when the crewman's finger slipped such that there was uneven pressure exerted on the PBI without the switch being fully released or depressed. As a result, the B and C switch contacts were closed while the A contact remained open and caused a miscompare for 3 consecutive cycles (6.25 Hz) of orbit switch FDI processing. The FAIL discrete for contact A (V90X7814X) (figure 1.3.1) was set and the contact was deselected by RM. Subsequently, the PBI was checked by the crew by depressing the switch and observing, on the ground, the A, B, and C contacts close then open when the switch was released. This indicated there was no actual hardware failure only a transient signal type failure, which caused RM deselection of the contact due to insufficient contact closure.

The PBI's have a small amount of mechanical play in the socket which makes it difficult to protect RM from this failure mode. Switch FDI can be inhibited via the RM switch spec function but this will cause loss of protection if there is an actual hardware failure. A memory read/write can be done to reset the logic and make the contact available to RM again, but the potential impact here is well known.

This RM failure was the result of the physically awkward procedure of holding depressed all 3 DAP mode PBI's while expanding the GPC set. Simultaneously holding depressed multiple PBI's greatly increases the probability that at least one will be relaxed enough to break one or two sets of contacts for the one-half second required to trip RM. The purpose of this procedure is to prevent erroneous PRCS jet fails from occurring because of upmoding to NORM during the GPC reconfiguration. It is necessary to hold depressed only the VERN PBI to accomplish this. In this case the SELECT and CONTROL modes were already selected to the upmode position, but even if this were in different positions these controls can be reconfigured after the GPC set expansion/collapse is completed.

We recommend that crews be specifically trained to apply this procedure to the VERN PBI only and to hold it firmly depressed.

4/102
 TIME 3:21:26:30

DAP CONTROL SWITCH RT1520E

SITE	SDA	BOA	GN 22 BUC	SM 24 BUC	ORR 5F LOW	RT1520E PAGE 1 HIGH
4-3 DAP CNTL SM						
V72						
2846X AUTO 1						
2847X AUTO 2						
2848X AUTO 3						
2849X MAN 1						
2840X MAN 2						
2841X MAN 3						
V98						
7814X AUTO 1 FAIL						
7815X AUTO 2 FAIL						
7816X AUTO 3 FAIL						
7817X MAN 1 FAIL						
7818X MAN 2 FAIL						
7819X MAN 3 FAIL						
4-3 DAP CNTL SM						
V72						
6496X AUTO 1						
6497X AUTO 2						
6498X AUTO 3						
6499X MAN 1						
6490X MAN 2						
6491X MAN 3						
V92X						
7724X AUTO 1 FAIL						
7725X AUTO 2 FAIL						
7726X AUTO 3 FAIL						
7727X MAN 1 FAIL						
7728X MAN 2 FAIL						
7729X MAN 3 FAIL						
0624 D:H	182:12	182:12	182:12	182:12	182:11	182:11
0625 H:S	:26:38	:26:06	:13:38	:11:08	:41:40	:41:40
0626 D:H	182:12	182:12	182:12	182:12	182:11	182:11
0627 H:S	:26:29	:26:04	:13:29	:11:07	:41:39	:41:39

FIG 1-3.1

6.1.11

NO. STS _____ FOD STS PROBLEM ENTRY FORM (PAGE 1) DATE FILED 12/7/82
 CLOSED 1-1-1 REV _____
MISSION(3) _____ VEHICLE(7) ORBITER DISCIPLINE(10) GNC
STS - 4 _____ MAJOR COMPONENT(15) DAP
SUBSYSTEM(20) GNC MINOR COMPONENT(15) DAP AUTO PBI RM SERIAL NUMBER(20) N/A
CONTACT: FOD- Len Hardwick E&D- _____
MAILCODE/PHONE CF6/5595 OTHER- _____
RIC- _____
MAILCODE/PHONE _____
PROBLEM IDENT:
CAUSE(8) PROC FAIL MODE(12) UNSAT COID
MISSION PHASE(12) ORBIT GMT OCCURRED 182:12:12:00 GMT RECOGNIZED 182:12:12:30

PROBLEM DESCRIPTION: (1092)

RM detected contact A on the Forward DAP AUTO pushbutton during 201-200 transition. The switch broke out with 4 sec. and contact subsequent to this occurrence, 4 sec. occurred. One possible explanation for this occurrence is that the cover did not maintain contact pressure on the AUTO PBI during 200 transition and contact A did not make solid contact. CFM would react as though a failure occurred.

FOD STS PROBLEM ENTRY FORM (PAGE 2)

PROBLEM RESOLUTION: (1092)

- HARDWARE/SOFTWARE FIX
 FLY AS-IS
 PROCEDURAL WORK AROUND
 SMS CHANGE REQD
 COMPLETED (SMS)

The decision was made to the in-flight position. If
 ground contact was lost, however, the pilot would be
 unable to select AUTO from the forward station. There
 were two possible, which- scenarios considered. First, a
 second time, and/ or, was developed which would have
 reset the pilot's contact in RM. Second, there was consideration
 given to Loss- IPL at the intention to clear the RM
 (possibly, within scope of action was considered necessary
 by management.

REMARKS: (160)

HARDWARE IDENTIFICATION:	PART NAME	PART NUMBER
SYSTEM/COMPONENT	N/A	N/A
NEXT HIGHER ASSEMBLY		
	MANUFACTURER	SERIAL/LOT
SYSTEM/COMPONENT	N/A	N/A
NEXT HIGHER ASSEMBLY		

PROBLEM EFFECTIVITY: N/A
 VEHICLE NUMBER _____
 MISSION NUMBER STS _____ STS _____ STS _____

ATTACHED DATA: (110) DAP CONTROL SWITCH MSK 1520

REFERENCES: (110)

2.0 IMU Performance

2.1 Discrepancies in Star Align Data

Introduction - During the first three flights, we observed that the star alignment data, namely the misalignment angles for each IMU axis, varied as the star pair on which they were based varied. This was most notably observed on STS-3, but has also been seen on STS-1 and STS-2.

Description of the Problem - If the star alignment system was perfect, the IMU misalignment angles (torquing angles) would be exactly the same for different star pairs (which means different vehicle attitudes), discounting the effects of platform drift. The phenomena observed on STS-3 demonstrated that our system is certainly less than perfect, and occasionally outside of the 3σ spec performance limits. On STS-3, the thermal attitudes flown allowed the star trackers to sweep large portions of the sky and acquire many stars of opportunity. Torquing angles generated by a star pair were computed by the onboard software. As the vehicle continued to rotate, a new star pair was acquired and new torquing angles were generated. Even though these sets of data were computed only a few minutes apart, the variation between the two angles for a given axis was as large as .09 deg. The 1σ specification for the process of measuring the torquing angles is .02 deg. If we assume errors on both measurements, then the 3σ spec would be .075 deg.

STS-4 Performance - Unfortunately, the attitudes flown during STS-4 were not favorable for the acquisition of stars of opportunity; therefore, we don't have the data base we had on STS-3. In addition to the unfavorable attitudes, we were also hamstrung by the star tracker's shutters being latched shut by the target suppress bit in the tracker. The attitudes being flown on STS-5 look more favorable for stars of opportunity and the target suppress bit should no longer be a problem because of a software change.

Conclusion and Recommendations - Although there is a wide disparity of opinion concerning the variations in torquing angles. We believe that they are caused by errors in the IMU resolver reads of the gimbals angles. This is substantiated by the enclosed plots which show a sinusoidal behavior of the IMU attitude differences (figures 2.1.1, 2.1.2, 2.1.3) during a period on STS-2 where the vehicle was flying a -ZLV attitude. The period of the oscillations match the orbital period (90 min), which says that as the gimbals rotate with the vehicle, a non-linear attitude is output by the IMUs. This type of behavior will cause the variations we see in the torquing angles. Also enclosed is 30 minutes of data (figure 2.1.4) during a PTC period of STS-4. Although there is not enough data to be conclusive, the same sinusoidal behavior is suggested. Because of these variations in torquing angles and the sinusoidal nature of the attitude outputs, we are considering a recommendation to E&D that the IMUs on OV-102 be tested in the JSC ISL lab. Since OV-102 will be down for mods, this will be an excellent opportunity to try to correlate ground testing with the type of behavior observed during the five flights.

GYRO DELTAS
 (DIFFERENCE BETWEEN OUTPUTS
 OF IMUs 1 & 3 - ATTITUDE)

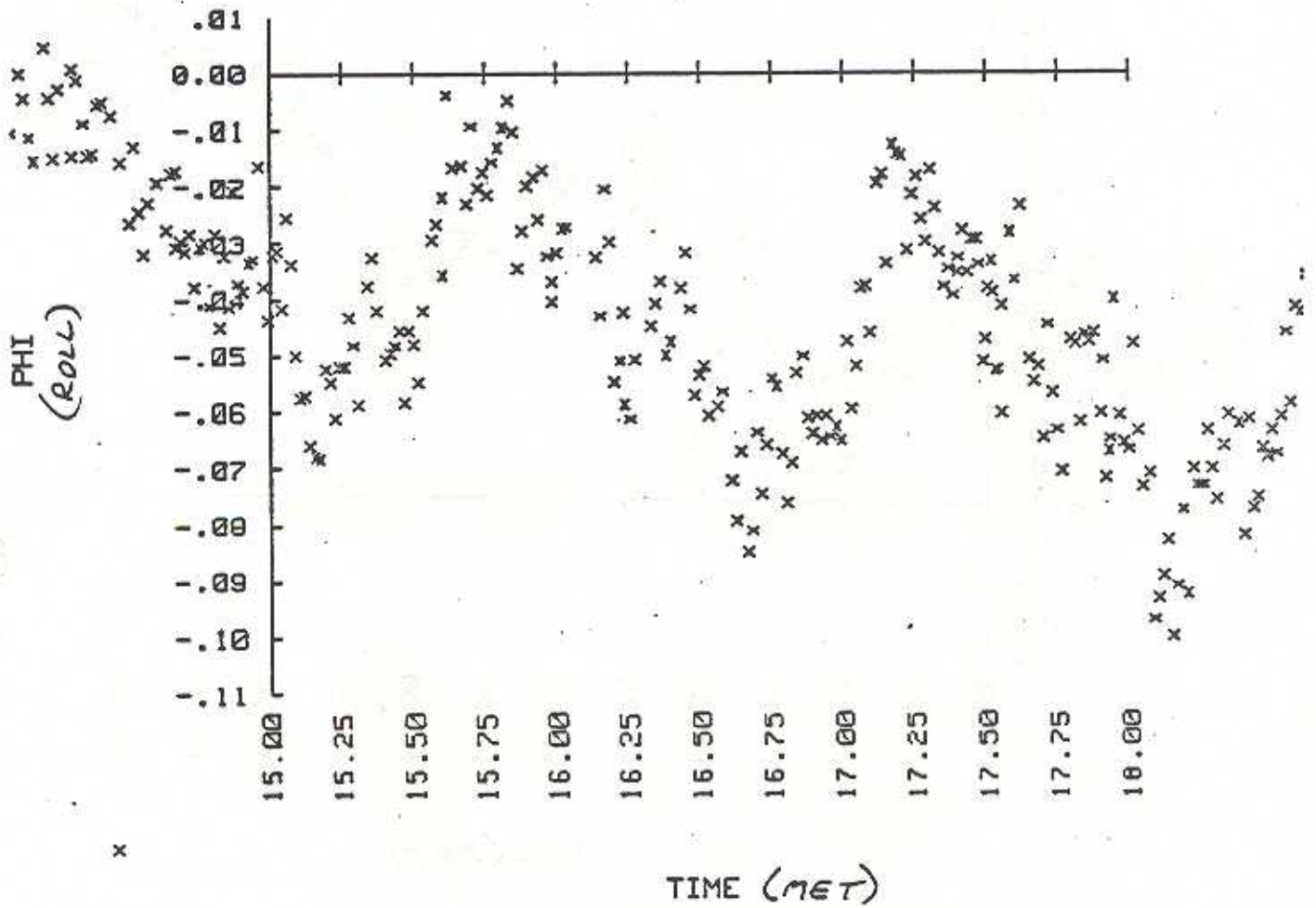


FIG 2.1.1

GYRO DELTAS
(IMU 1 - IMU 3)

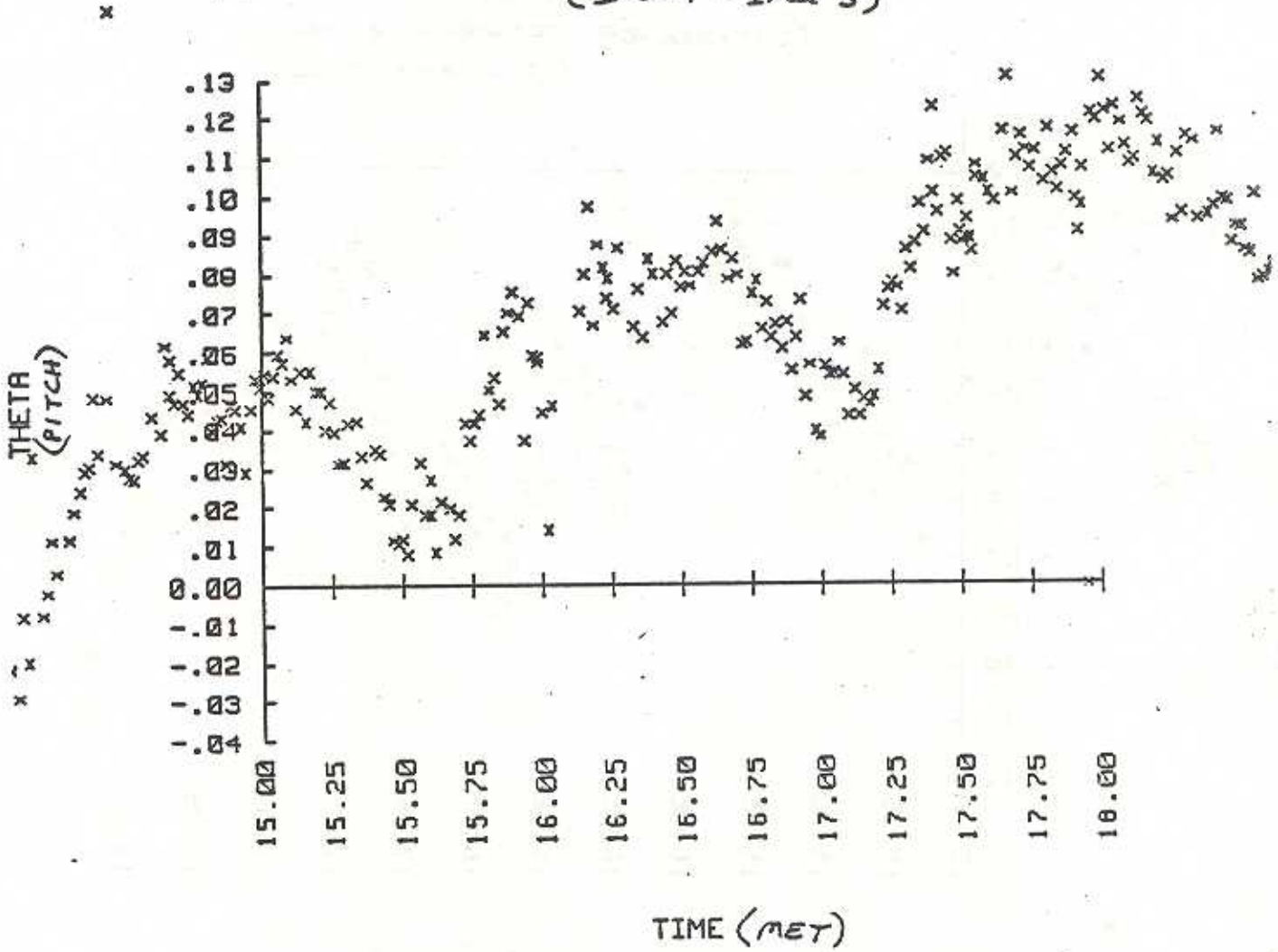


FIG. 2.1.2

6-1-16

GYRO DELTAS
(IPL 1 - IPL 3)

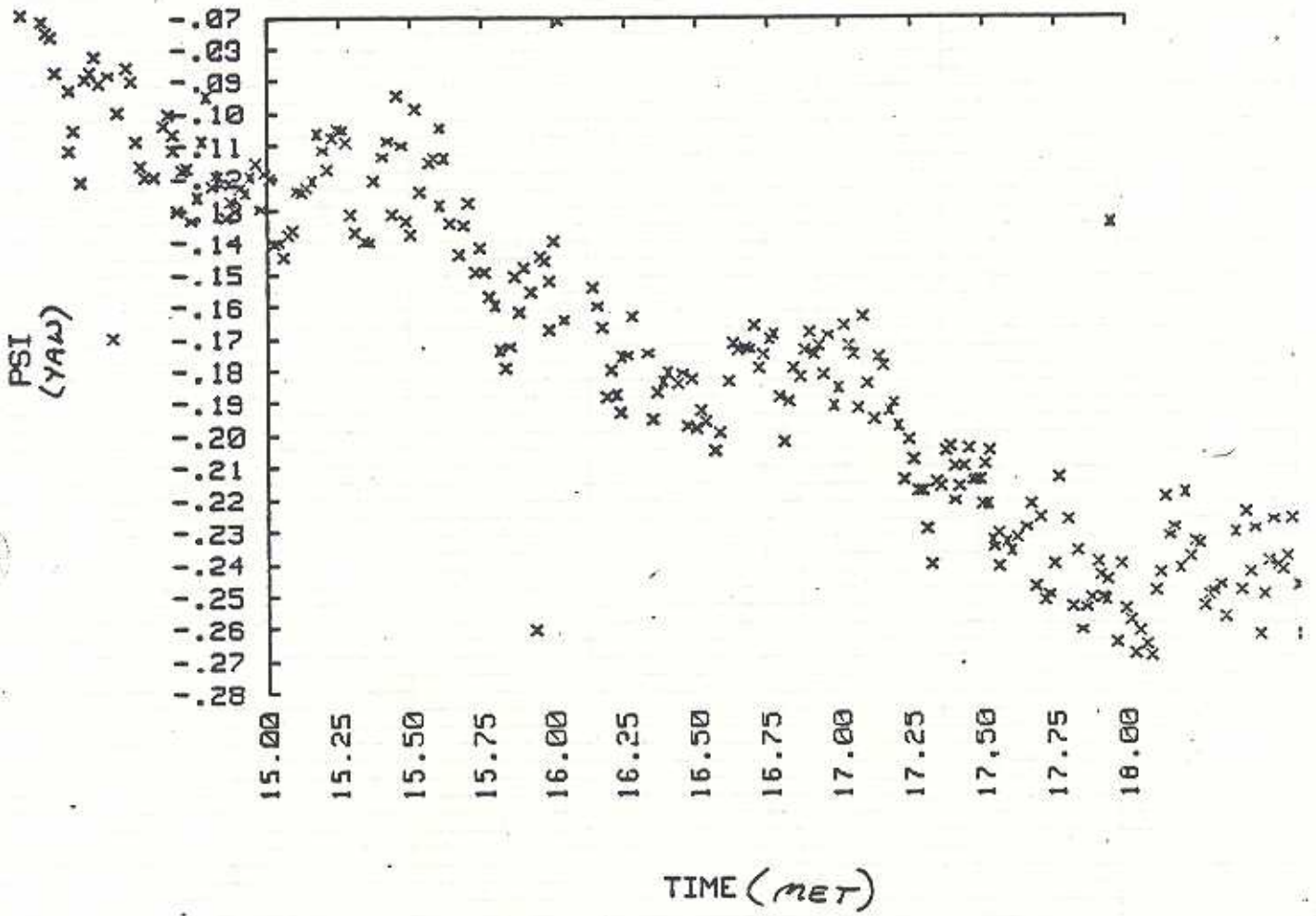
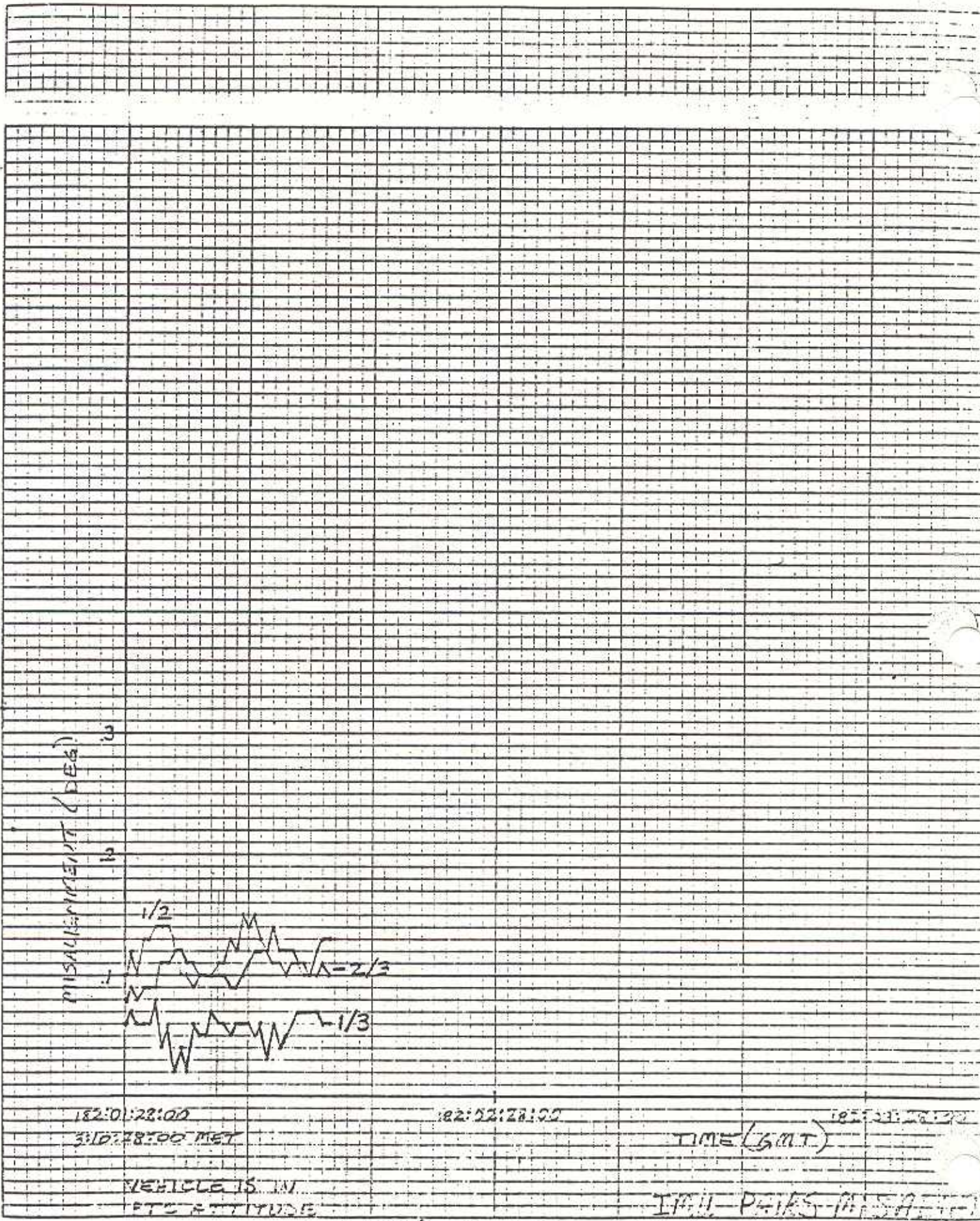


FIG 2.1.3



6.1.18

2.2 Attitude Dependency of IMU Drifts

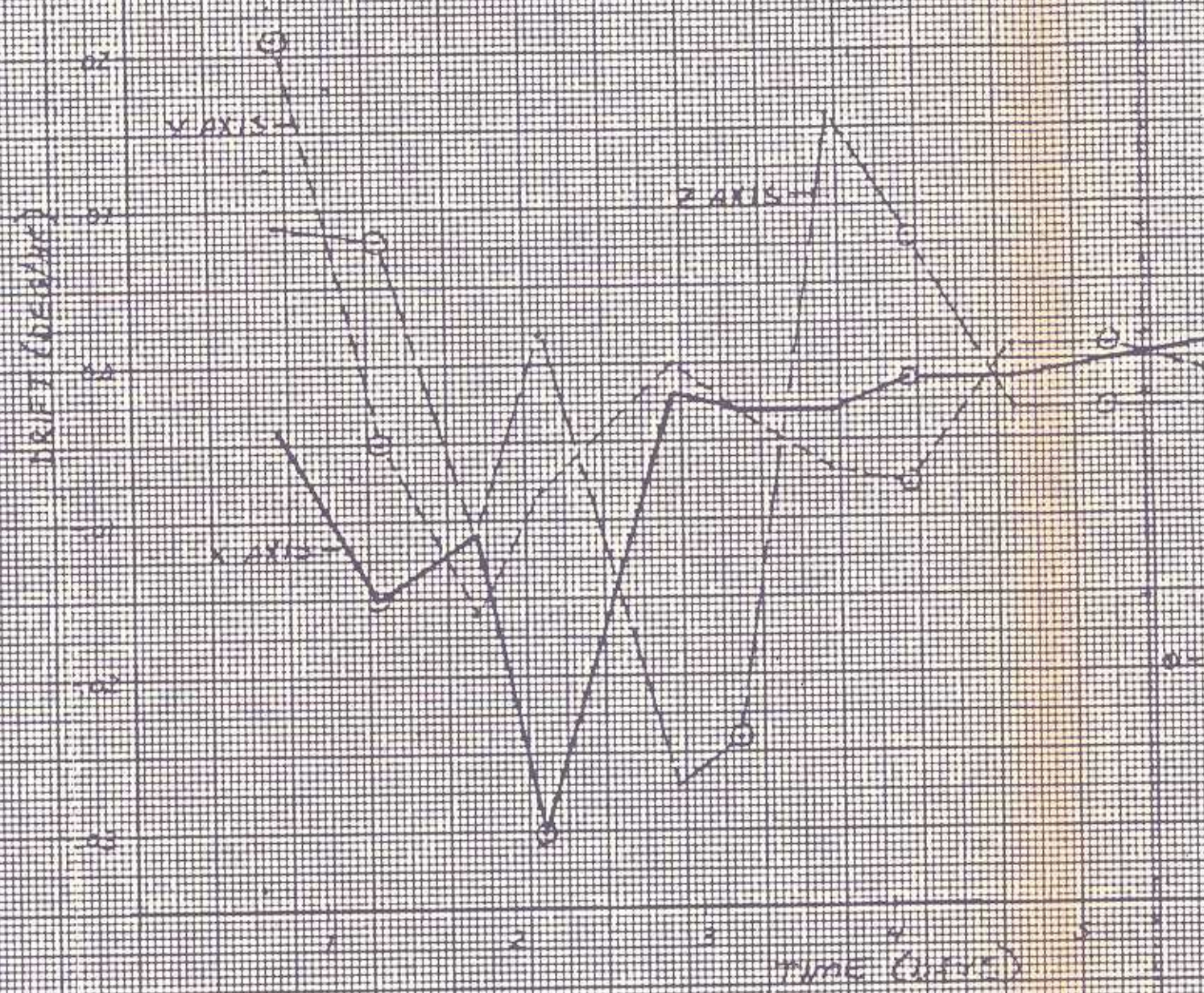
Introduction - During the first three flights we noted that the drift characteristics of the IMUs changed during the course of the flight. STS-1 and STS-2 were such short flights that we really could not draw any conclusions about the nature of the drift. On the subsequent flights, though, we were able to observe that as the predominant attitude of the Orbiter changed, so did the IMU drifts.

Description of the Problem - The on-orbit drift performance of the IMUs has been outstanding ($< 1\sigma$) when the vehicle has flown in the same orientation for long periods of time. For example, on STS-3 when the vehicle flew the nose sun attitude for such a long period of time, we were able to calibrate the drift so well that we went 27 hours without an alignment. When we changed from the nose sun attitude to the top sun attitude, though, almost every axis of the 3 IMUs required compensation to negate the new drifts. IMU 3Z was most susceptible to this "orientation sensitivity," the magnitude of the drift change being .06 deg/hr.

STS-4 Performance - As shown on the enclosed plots (figures 2.2.1, 2.2.2, 2.2.3), the measured IMU drift did vary and several updates were necessary to maintain the drift at a less than 1σ level. IMU 1 Z shifted by .03 deg/hr when the attitude changed from a tail sun to bottom sun attitude in the 2-3 day MET time period. During this same period IMU 3 Z shifted by .04 deg/hr. These two shifts were the largest observed, although several other smaller attitude dependent shifts were observed. During the long tail sun period, the IMU drifts were extremely small, once again showing that the drift performance is excellent when the vehicle stays in a given attitude for an extended period.

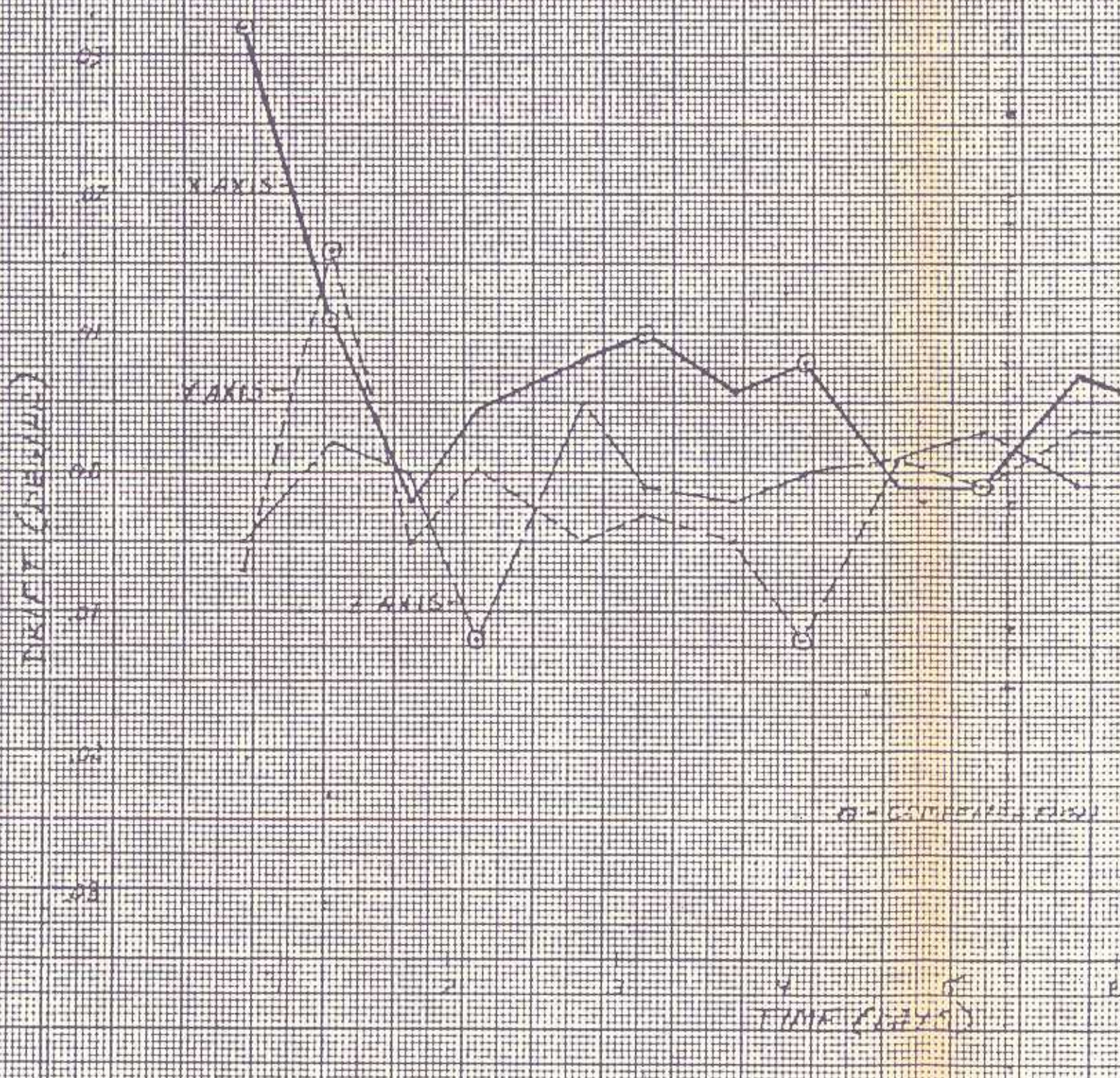
Conclusions and Recommendations - The IMUs do demonstrate an orientation sensitivity which can cause drift changes as high as 3σ (.06 deg/hr/axis). These changes necessitate continual monitoring of IMU drifts and many gyro bias compensation updates per flight. Given some dedicated ground testing, this orientation sensitivity could be measured and compensated for in the software. To this end, we are again considering this problem as part of the justification for testing them here at JSC. We are hoping to understand the significance of this orientation sensitivity and we also hope to determine its repeatability/predictability.

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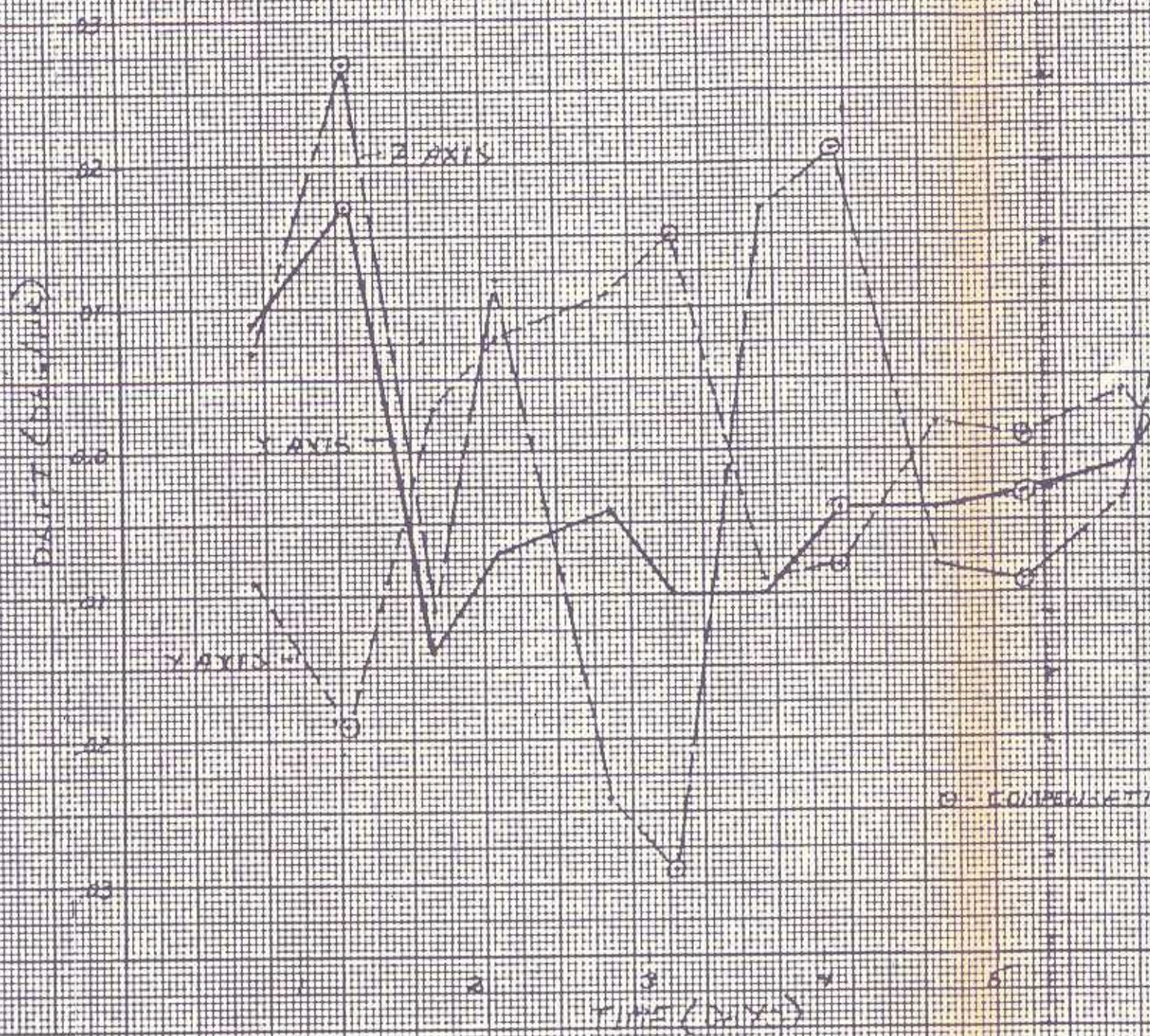
IMU 1 DRIFT
 AS MEASURED BY STAR ALGORS
 FIG 2.2.1

DATE	TOP SURVEY		BOTTOM SURVEY		WIND	TEMP	HUMID	SEA SURF	WAVE SURF
	WIND	TEMP	WIND	TEMP					
21	10	10	10	10					



TIME (DAYS)
 DRIFT
 AS MEASURED BY SURFACE CURRENTS
 FIG 2.2.2

DATE	TIME	TEMP	HUMID	WIND	PRECIP	DRIFT	REMARKS
10/10/50	0800	50	60	10	0.0	0.0	
10/10/50	1200	52	65	15	0.0	0.0	
10/10/50	1600	55	70	20	0.0	0.0	
10/10/50	2000	58	75	25	0.0	0.0	
10/11/50	0400	55	70	20	0.0	0.0	
10/11/50	0800	58	75	25	0.0	0.0	
10/11/50	1200	60	80	30	0.0	0.0	
10/11/50	1600	62	85	35	0.0	0.0	
10/11/50	2000	65	90	40	0.0	0.0	
10/12/50	0400	60	80	30	0.0	0.0	
10/12/50	0800	62	85	35	0.0	0.0	
10/12/50	1200	65	90	40	0.0	0.0	
10/12/50	1600	68	95	45	0.0	0.0	
10/12/50	2000	70	100	50	0.0	0.0	



MILLIB DRIFT
MEASURED ON THE FLIGHT

FIG 2.2.3

2.3 Onboard Navigation Errors at MECO

Introduction - On the first three flights, the navigation state has been biased in the negative crossrange position direction at MECO. On flights 1 and 2 this was thought to be due to an I-load error which affected the IMU azimuth alignment accuracy. This situation was corrected on STS-3 such that the azimuth alignment done in preflight was felt to be near perfect. The same crossrange errors occurred on STS-3, however, so the I-load correction was not the only error source.

Description of the Problem - The accuracy with which the azimuth axis of the IMUs can be aligned is directly correlated to the accuracy of the crosstrack position component of the nav state. When the azimuth alignment is thought to be near perfect and a nav state error is still present, one has to suspect other platform errors. Since the sensed velocity vector (which is fed to nav) is selected on a component by component basis (i.e., it could be that an axis from each IMU is used), it is unlikely that a random error source would produce the same errors on all flights. The thinking has been, however, that IMU drifts on the pad were a random process. But with three flights of data showing a bias in the same direction in nav, we started to question the randomness of the preflight drift about the Up axis.

Figures 2.3.1 through 2.3.18 are plots of the position and velocity errors for STS-2 and STS-3. The plots show the nav errors for the downrange (U), vertical (V), and crossrange (W) positions and the corresponding velocity errors.

STS-4 Performance - We would like to report that STS-4 showed a different signature than the first three flights, but that is not the case. The position and velocity errors during ascent looked identical to the errors on the first three flights, as shown in the enclosures.

Conclusions and Recommendations - The nav state errors are apparently due to a drift about the Up axis on all three IMUs. We realized that the platforms would drift about Up since we can't calibrate that axis as well, but we felt the drift would be random. The data from the first four flights appears to indicate that the platforms drift in the same direction and at roughly the same rate each flight. We are assessing the performance impact of this error.

A CR has been submitted which will allow an I-loaded number to be used as compensation for Up axis drift during the time from T-20 min to T-12 sec (tuned inertial mode of the IMUs). If the CR is approved, the vendor would have to provide the number for this I-load which would mean further factory calibration and therefore more cost. The Up axis drift is much larger than the drifts on the other axis and therefore is our major source of error in preflight. To eliminate the nav errors and increase the allowable hold time on the pad, this CR should be approved.

3.0 Gravity Gradient

3.1 Performance - Attempts to establish a gravity gradient attitude were initiated on two separate occasions. The first gravity gradient period was at 178:20:41:00 on the first day of the fourth mission. The second gravity gradient period was at 179:16:23:00 of the second day. The general guidelines for the establishment of gravity gradient are that the crew must release the Orbiter with as small a rate of movement as possible. Additionally, excessive movements within the vehicle by the crew or venting of any type during the period is prohibited. The general Orbiter attitude to accomplish gravity gradient is with its nose pointed to the center of the earth and its +Z axis pointed generally toward the velocity vector. Violations of these general guidelines can prevent establishment of a successful gravity gradient equilibrium. Below are the gravity gradient period results and a synopsis of the data gathering procedures.

3.1.1 Day One - The day one gravity gradient (gg) test was started at 178:20:41:00 at a pitch, yaw, omicron of 357.51, 0.97, and 249.18 degrees respectively. This test was unsuccessful. There were unknown forces much greater than gravity gradient forces acting on the vehicle and all three axes were divergent. The initial attempt was terminated at 178:21:10:00 with maximum attitude errors in roll, pitch, yaw of 117 degrees, -13.6 degrees, and 18.9 degrees respectively. The maximum rate errors seen in roll, pitch, yaw were -0.196 degree/sec., 0.055 degree/sec., and 0.085 degree/sec respectively. (See figures 3.1, 3.2, 3.3).

A restart of gg was performed at 178:21:29:00 with a change in omicron to 244 degrees and leaving pitch and yaw the same at 357.51 and 0.97 respectively. The omicron change was based on the orbit being 161 n miles versus 165 n miles. This attempt was somewhat more stable in pitch and yaw for the first 50 minutes before the same magnitude of force caused a divergent condition. Roll on this second attempt still was not acting stable as it had drifted off 40 degrees in the first 50 minutes before the divergent condition was apparent. This second attempt was terminated at 178:22:42:00 with maximum attitude errors in roll, pitch, yaw of 262 degrees, 4.6 degrees, and -20.7 degrees respectively. The maximum rate error seen in roll, pitch, yaw were -0.279 degrees/sec., -0.087 degrees/sec., and 0.099 degrees/sec., (see figures 3.4, 3.5, 3.6).

There was an apparent correlation between the force acting upon the Orbiter and the sunlight striking the vehicle. The first attempt to establish gravity gradient was started at sunrise and was immediately divergent. The second attempt was started at sunset with less divergence noted through the night pass. However, at sunrise the Orbiter diverge immediately (see figure 3.7, 3.8). At this point there was a suspected vent occurring on the vehicle which became more active as the vehicle entered sunlight. Venting of any sort violates the general guidelines for establishing gravity gradient equilibrium. The DAP errors were monitored throughout the sleep period with the same correlation noted between a venting force and sunlight. Attempts to isolate the location of the venting force were undertaken. It seems that the venting force provided a roll torque of approximately 1.76 ft/lbs, and was located in a plane through the center of gravity containing a body vector pitch of 13 ± 10 degrees and a yaw of 76 ± 10 degrees. The approximate location of the venting force would be located near the center of gravity in the

payload bay. At no time during the planning phase of this mission was there any indication of a venting problem originating from this location.

- 3.1.2 Day Two - The day two gg test was changed from 12 hours period to a $5\frac{1}{2}$ hour test late in the day. The large unknown forces appeared to have become significantly smaller. The gg test was started at 179:16:23:00 at a pitch, yaw, omicron of 357.51, 0.97, and 245 degrees respectively. This test can be considered successful with a stable gg attitude biased off slightly in the negative error direction. The maximum attitude errors seen in roll, pitch, yaw were -25.19, -3.33, and -7.93 degrees respectively. The period of oscillations was 56 minutes in pitch and yaw and 109 minutes in roll. Looking primarily at the roll axis, the first 2 hours of data is under the influence of the gg release conditions. After 2 hours, roll appears to be stabilizing around a new reference point (-4 degree error), but there is only $1\frac{1}{2}$ cycles of data on which to make that conclusion. Both pitch and yaw look stable around slightly negative errors of -0.5 and -1.5 degrees respectively. Using these errors a new gg start attitude was determined to be pitch, yaw, omicron of 357.58, 1.14 and 249 degrees respectively (see figures 3.9, 3.10, 3.11).
- 3.1.3 Ground Evaluation Procedure - The following is a discussion of the procedures utilized to obtain and plot the gravity gradient data for analysis. The team which performed this task consisted of 3 people per shift plus 1 overall gravity gradient monitor. The console representative hardcopied MSK 2023, universal digital display, which had 10 data parameters on it consisting of total attitude errors, ADI rates, LVLH attitudes for roll, pitch, and yaw, and onboard GMT. Hardcopies were taken realtime and from playback data at 1 minute intervals. The console representative kept a log of the time interval when data was hardcopied. Coordination with the Data Integrator was initiated, if any time intervals were missing. The other two individuals retrieved the hardcopies, placed them in chronological order, plotted the total attitude errors and ADI rate information for each 4 minute interval, and coordinated with the console operator on missing data. The gravity gradient monitor insured that status reports, copies of plots, and any other information requests were provided as required. This procedure seemed to work smoothly; however, there were instances where information did not reach the correct source in a timely manner.
- 3.1.4 Summary - The day one gravity gradient period was unsuccessful due to an unknown vent originating from the payload bay area. Two attempts to start gravity gradient were made during the day one period. Both attempts were unsuccessful. The first attempt lasted 29 minutes before it was terminated because the total roll attitude error was 117 degrees. The second attempt was for 73 minutes and the total roll attitude error reached 262 degrees. The unknown vent experienced during day one was not as evident during the shortened day two gravity gradient period. Gravity gradient was started during day two and was not divergent. The maximum roll error was 25.19 degrees. The conclusion can be made that, if the general guidelines for establishment of gravity gradient are followed; i.e., no vents allowed, a stable gravity gradient attitude can be established

using vernier RCS while in a circular orbit.

3.2 Recommendations

1. Gravity gradient periods less than 3 hours are not adequate for data gathering efforts.
2. Gravity gradient needs to be proven using the primary RCS system.
3. Gravity gradient for elliptical orbits needs to be tested for its effects on the Orbiter.
4. It is critical that all vents be known and deleted prior to any gravity gradient period.
5. The gravity gradient data gathering team can be decreased from 3 to 2 individuals--a console representative and a plotter.
6. Hardcopies should only be taken at the beginning and end of a real time pass or playback interval plus only at 5 minute intervals in between.
7. Plotted data should be at 5 to 10 minute intervals except at maximum/minimum points where the interval should be increased.
8. Offices to receive gravity gradient results during the mission should be better defined so that timely and correct distribution of gravity gradient material can be made.

6.1.45

DAY ONE - First Attempt...

ROLL

FIRS, 79

REF ATTITUDE
P1 = 357.51
Y1 = 0.97
OMT = 249.18

ENGINE 10.8 TO THE CONTROLLER AS DATA OF

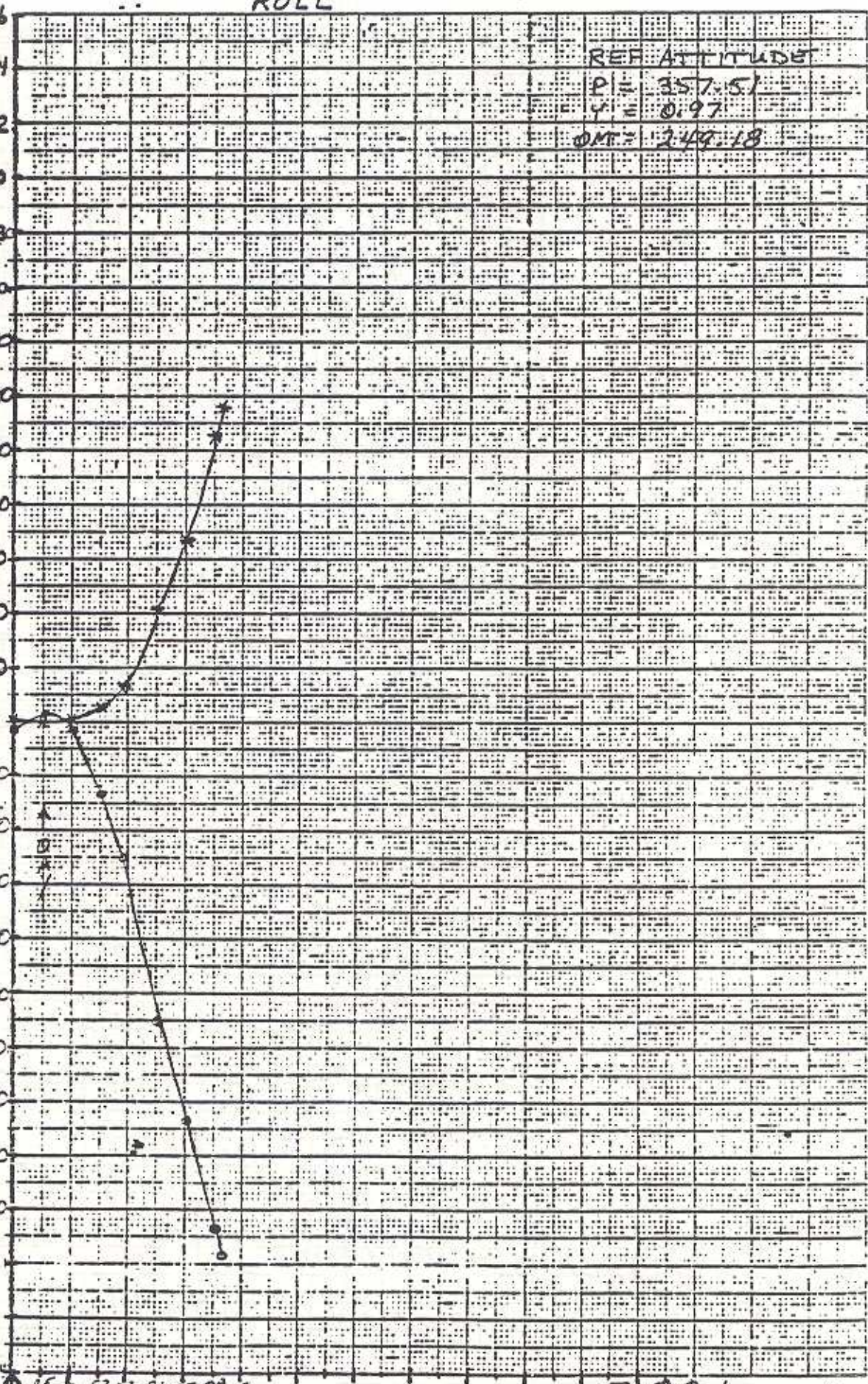
ENGINE 10.8 TO THE CONTROLLER AS DATA OF

ROLL RATE deg/sec

* ROLL ERROR deg

0 .026
.024
.022
.020
.018
.016
.014
.012
.010
.008
.006
.004
.002
0
-.002
-.004
-.006
-.008
-.010
-.012
-.014
-.016
-.018
-.020
-.022
-.024

26
24
22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24



TART GMT) 178/20:41:00

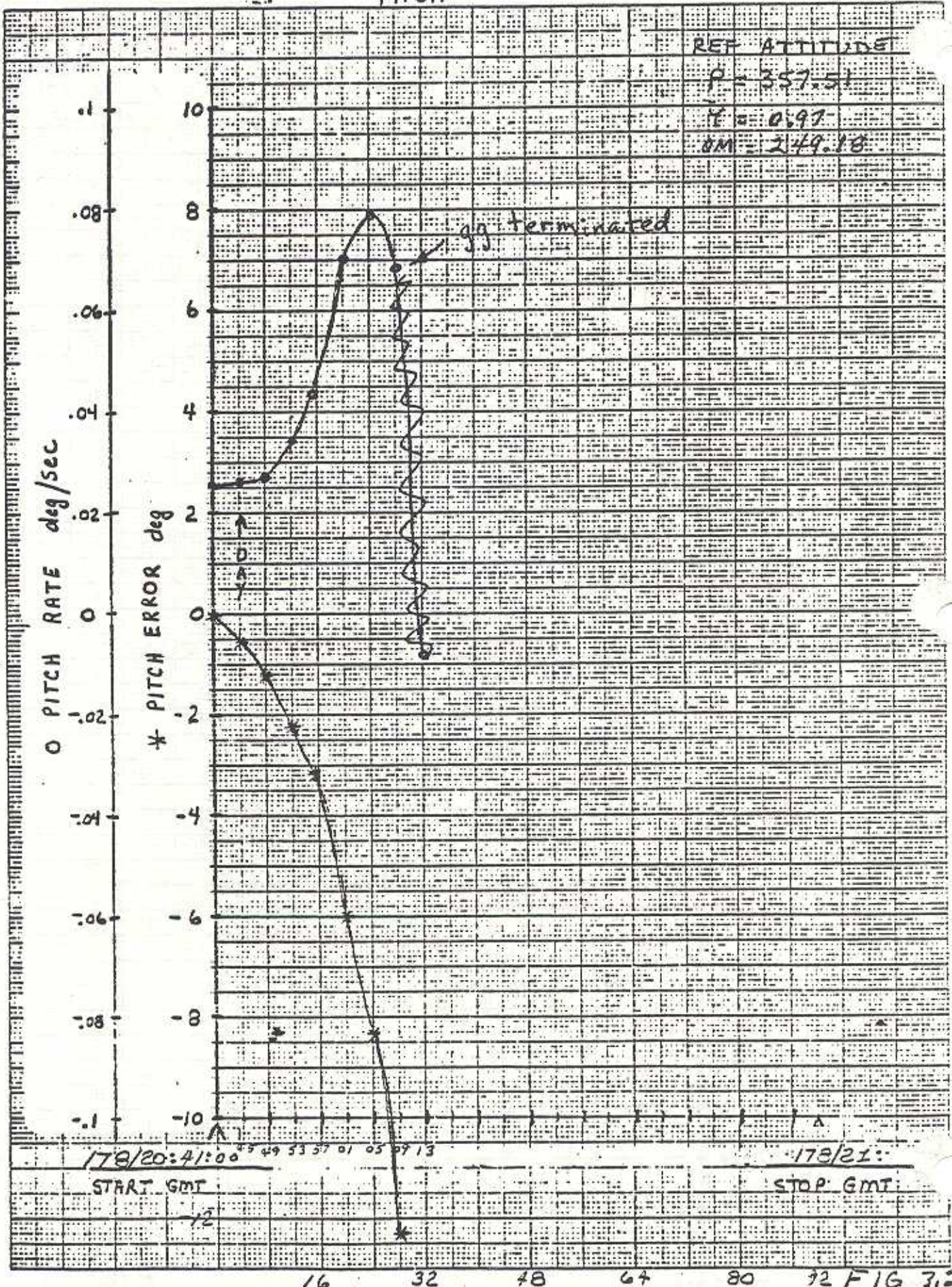
FIG 3.1

(STOP) GMT

6.1.46

PITCH

FIRST GC



178/20:41:00 49 53 57 01 05 09 13

START GMT

178/21:

STOP GMT

12

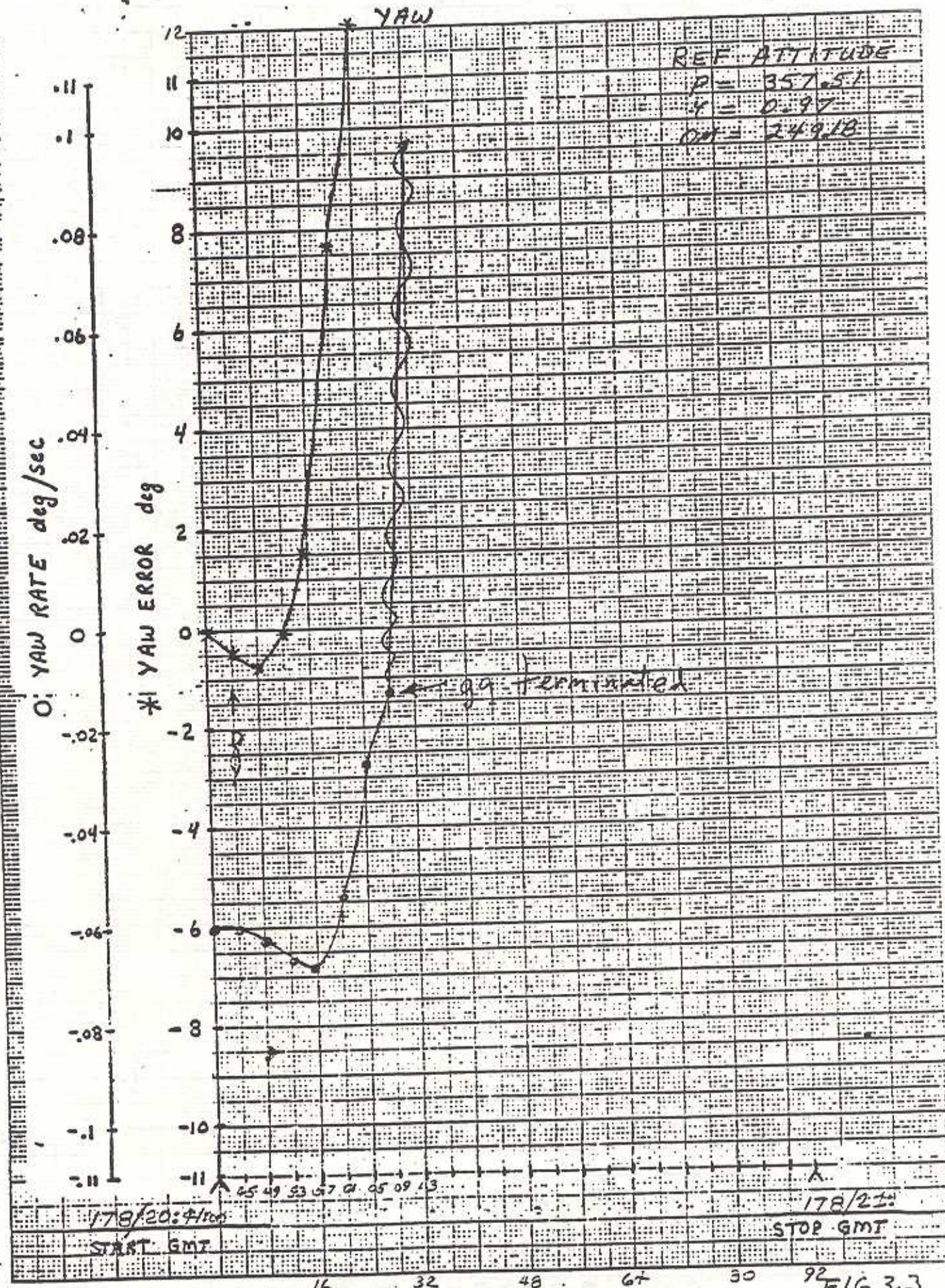
16 32 48 64 80 92 FIG 3.2

6.1.47

FIRST

FORM 10-1 IN THE CONTINUATION OF 1016 OF

USE GRAPHICALLY FOR GRAPHIC CONTROL COMPUTATION. BUREAU OF NAVAL WEAPONS DEVELOPMENT CENTER, WASHINGTON, D.C. 20340



6-1-48

FIG 3.3

START 178/21:29:00 DAY ONE - Second Attempt

ROLL

2ND GG

ENGINEERING RESEARCH CORPORATION, BOSTON, MASSACHUSETTS

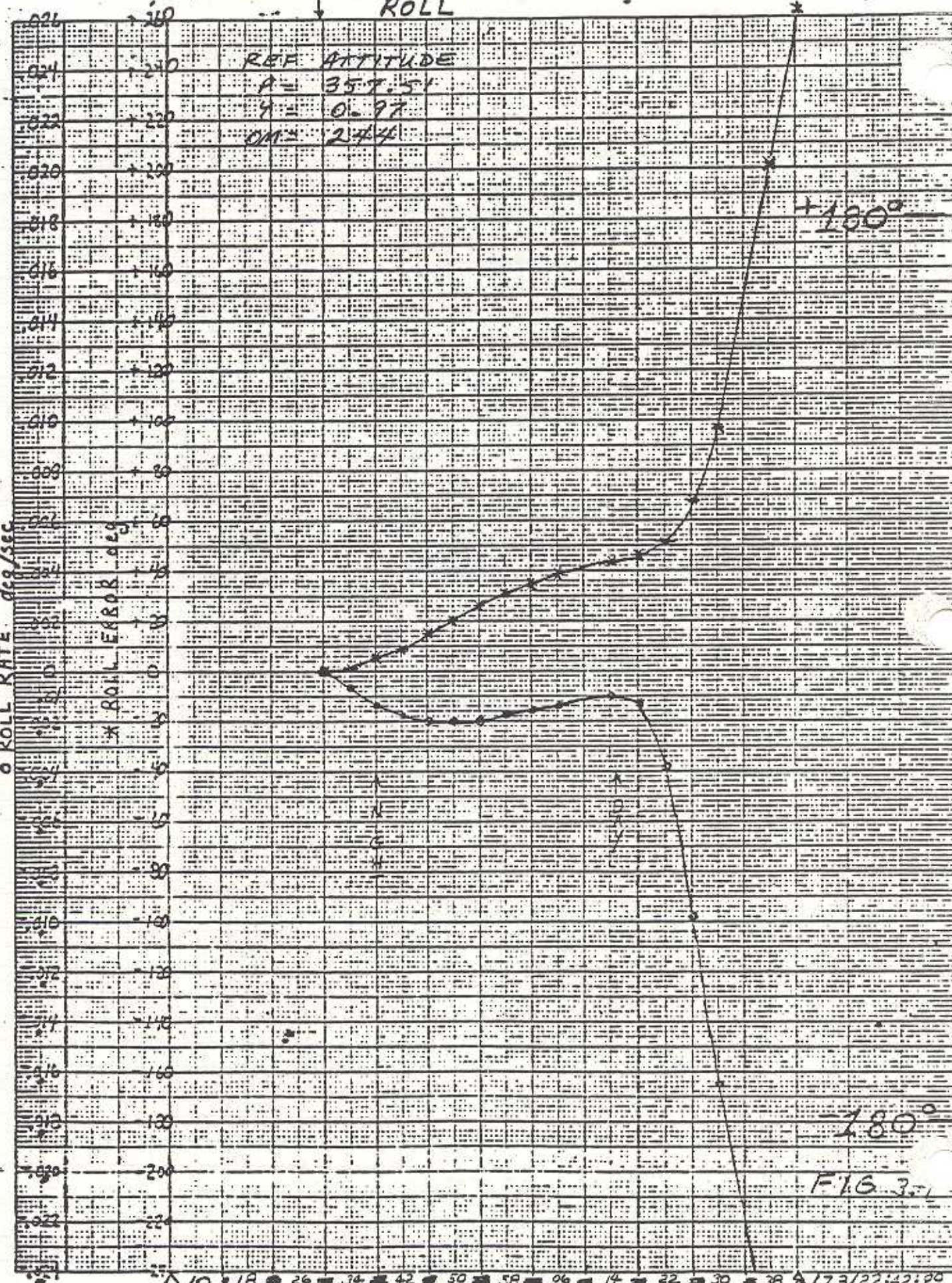


FIG. 3.1

6.1.49

DAY ONE - SECOND ATTEMPT.

PITCH

REF ATTITUDE

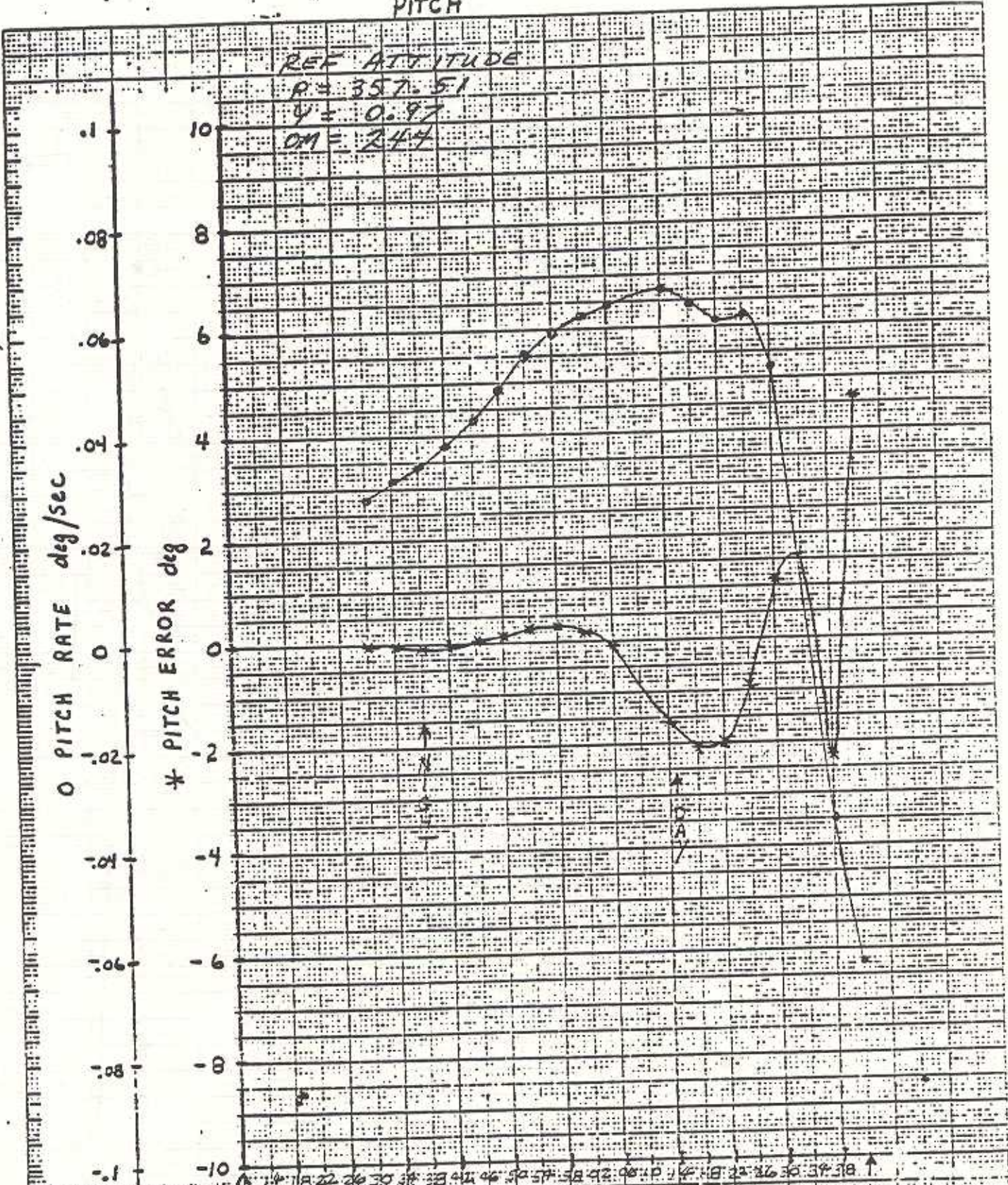
$R = 357.51$

$\psi = 0.97$

$OM = 244$

O PITCH RATE deg/sec

* PITCH ERROR deg



178/21:29:00

START GMT

178/22:42:00

STOP GMT

FIG 3.5

6.1.50

SCALE 10 X TO THE GRAPHIC

AS SHOWN

2nd GG

2nd GG

DAY ONE - SECOND ATTEMPT

YAW

REF ATTITUDE

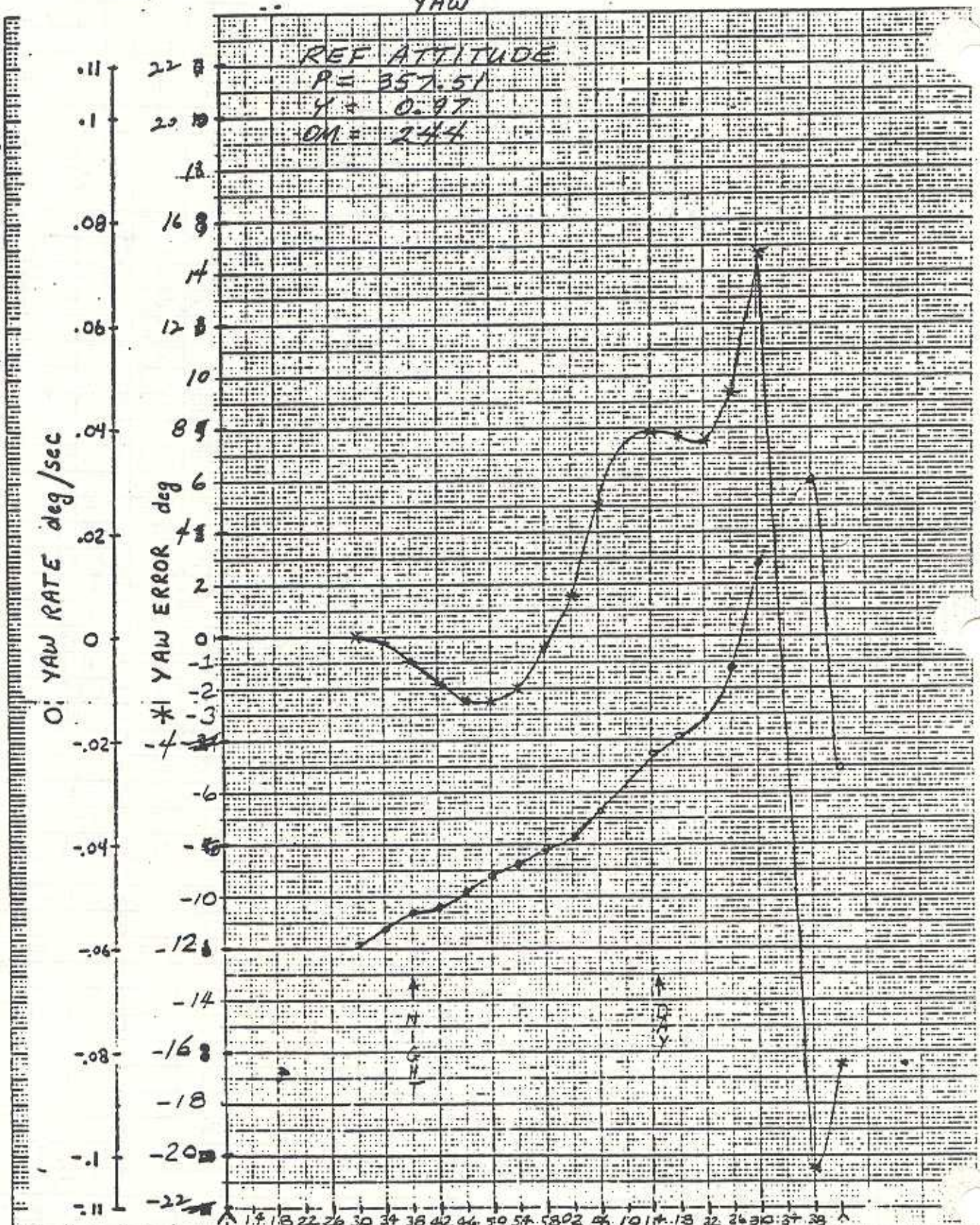
P = 357.51

Y = 0.97

OM = 244

O: YAW RATE deg/sec

* YAW ERROR deg



178/21:29:00

START GMT

178/22:42:00

STOP GMT

6.1.51

FIG 3.6

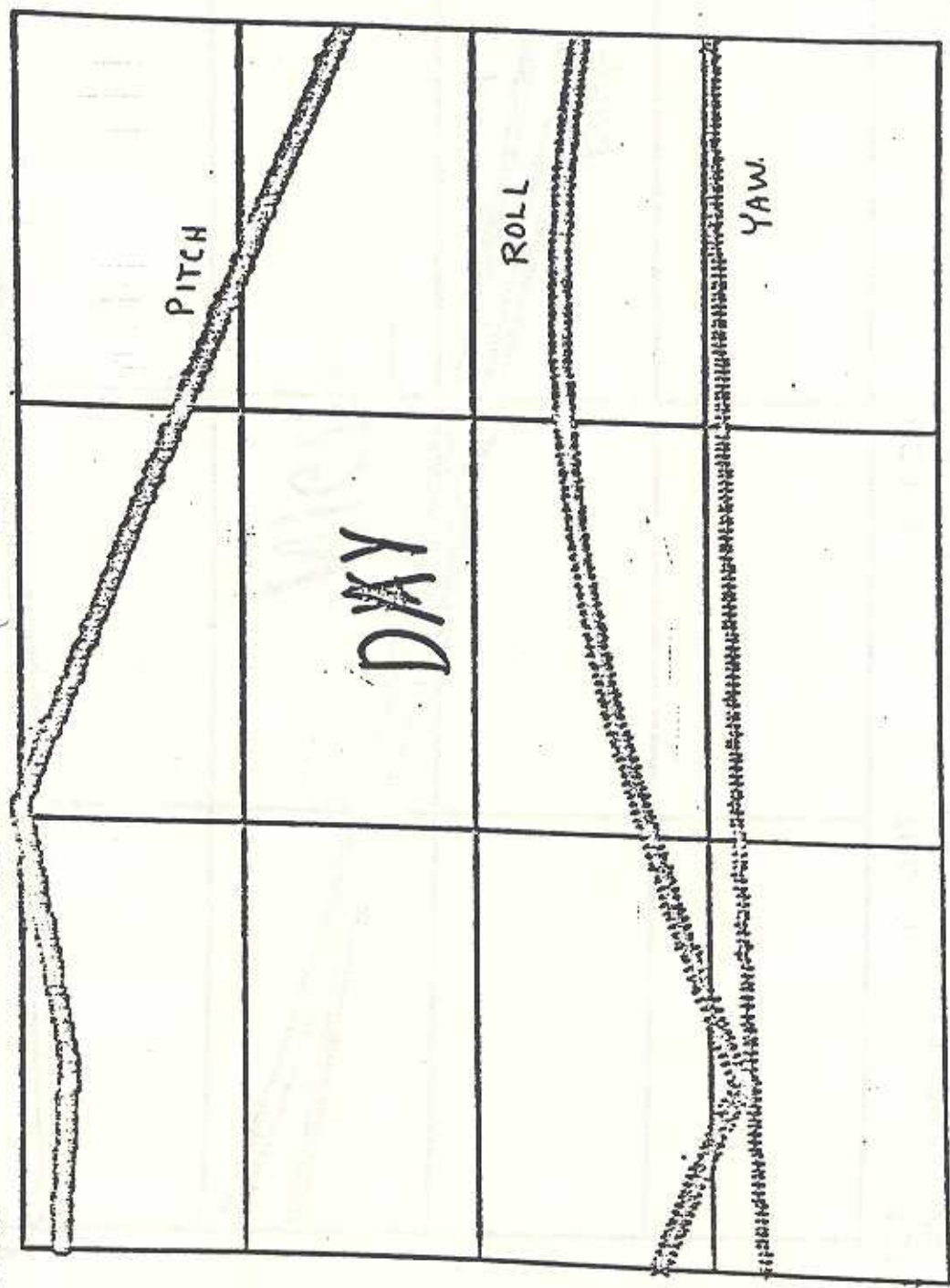
SOURCE: 10 X 10 ONE CENTIMETER AS SHOWN ON

USF 100-1-72-117 GRAPHIC ENGINEERING CORPORATION BOSTON, MASSACHUSETTS

2nd GG

WAY I / 9

4/102 GNC UP 2 RT1842C
 UDRATE SEC POINT 181 SITE AGO NOM=
 R DAP ERRS P DAP ERRS Y DAP ERRS MED SCALE
 V90H2143C =XL V90H2141C =OL V90H2142C =+L V72K8505X =AD
 -1.148 1.379 -2.588



+5.00

+2.50

DAP ATT. ERRORS

+0.00

-2.50

-5.00

M40H0107J

0 5:59 2 4 6
 OGNT=179:02:15:46 GND=179:02:15:46

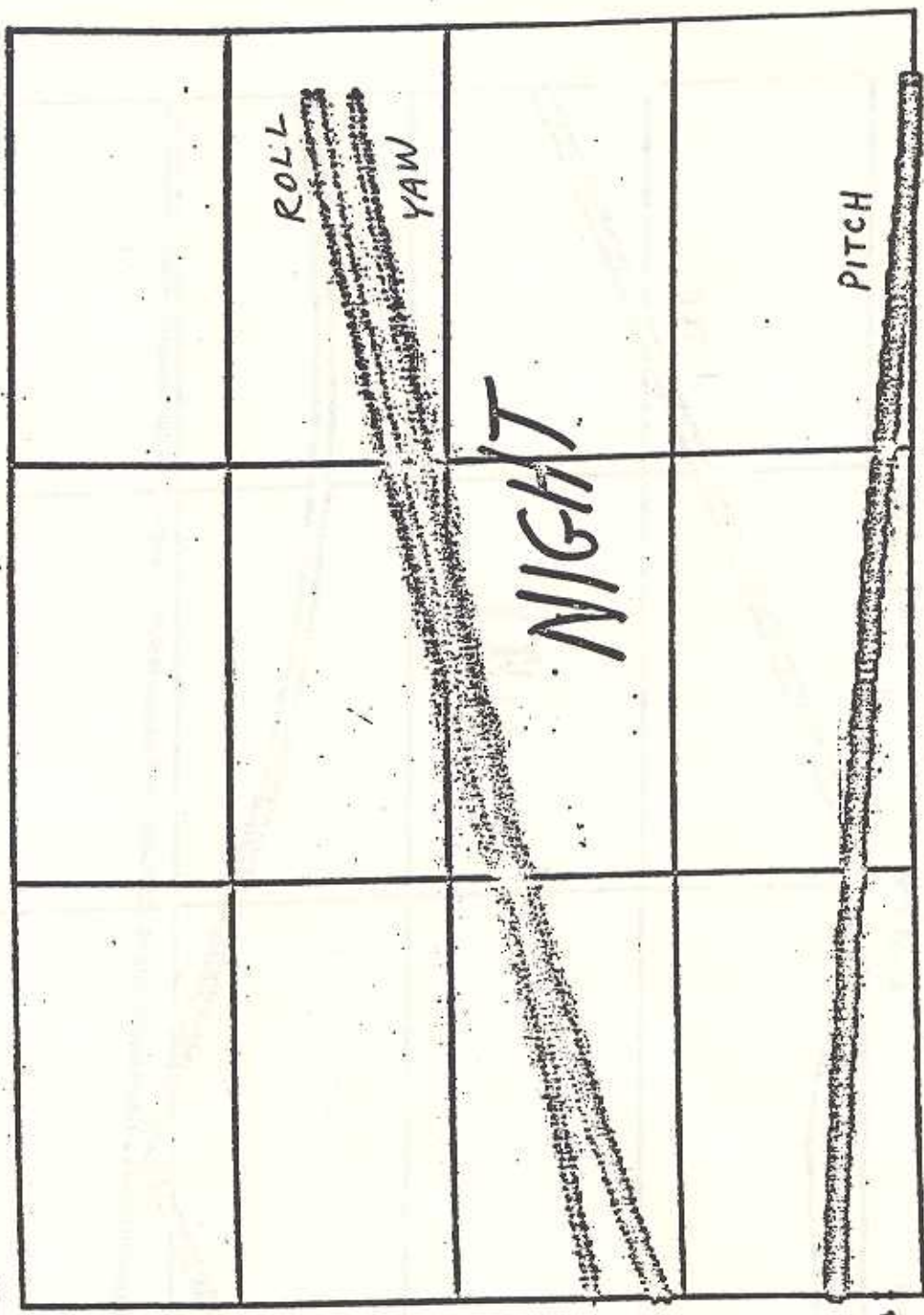
FIG 3.7

6.1.52

WAY I / 9
 0 2 4 6
 OGNT=179:02:15:46 GND=179:02:15:46

W W W W W

F/V 4/102 SEC POINT 172 SITE ACN NDM= GNC UP 2 RT1842C
UBRATE P DAP ERRS Y DAP ERRS MED SCALE
R DAP ERRS =XL V90HZ141C =OL V90HZ142C =+L V72K8505X =AD
V90HZ143C 1.521 -4.981 1.030



DAP ATT.
ERRORS
6.53

FIG 3.8

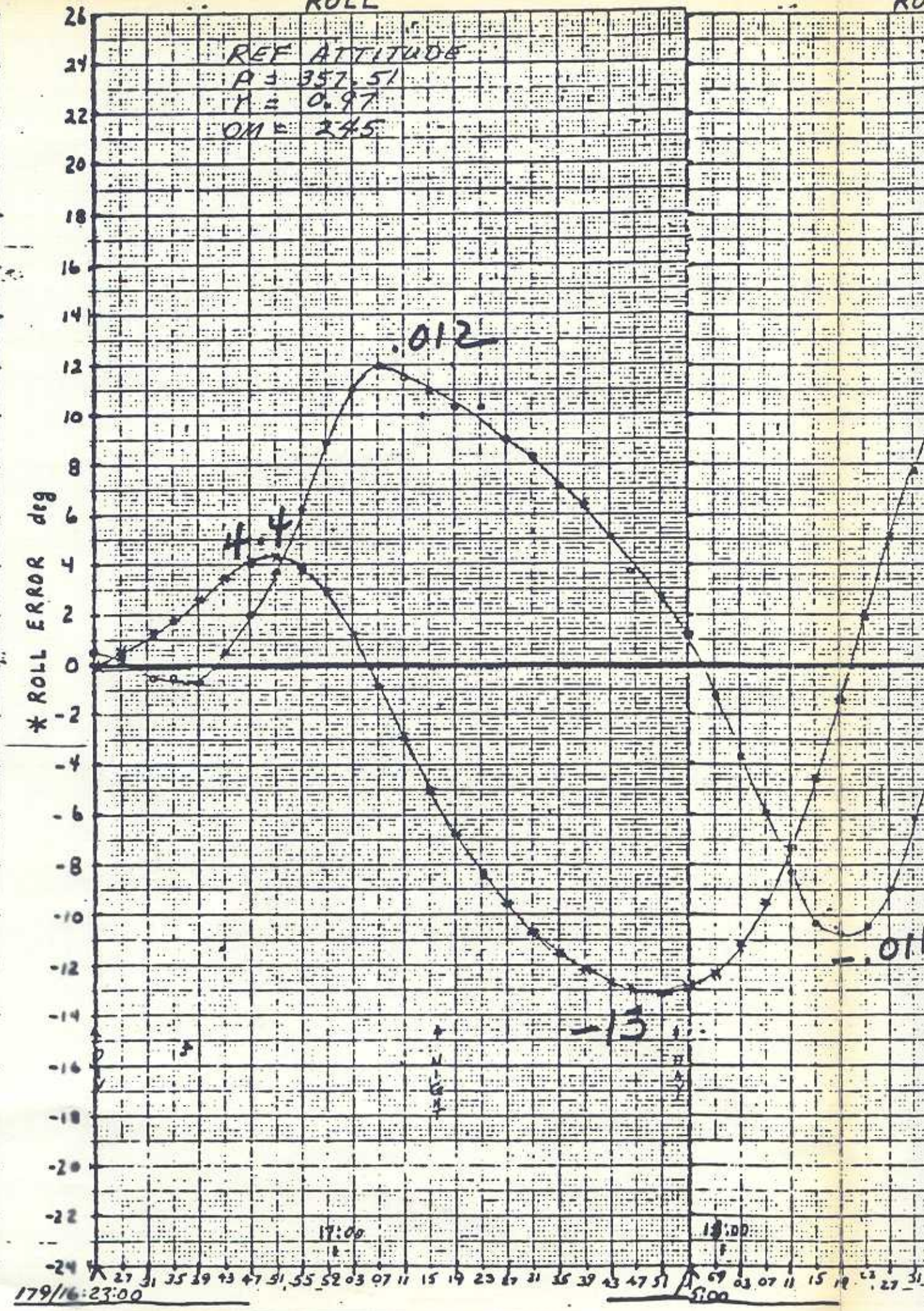
M40H0107J 5:42 OGMT=179:02:30:25 GND=179:02:30:25

ROLL

RO

REF ATTITUDE
A = 357.51
M = 0.97
OM = 245

ROLL RATE deg/sec
* ROLL ERROR deg



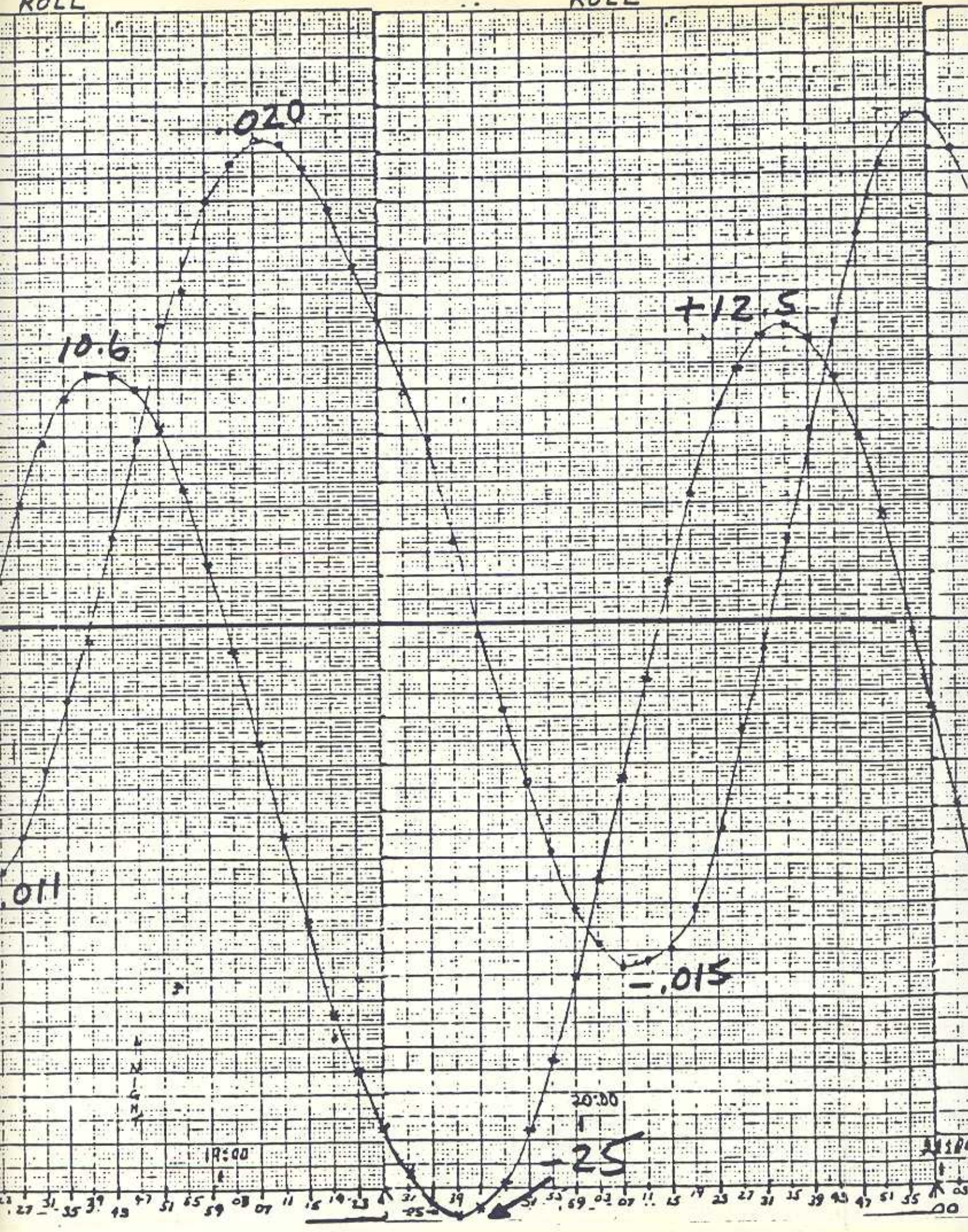
179/16:23:00

179/17:00
18:00

GMT)

ROLL

ROLL



.011

.020

10.6

+12.5

-.015

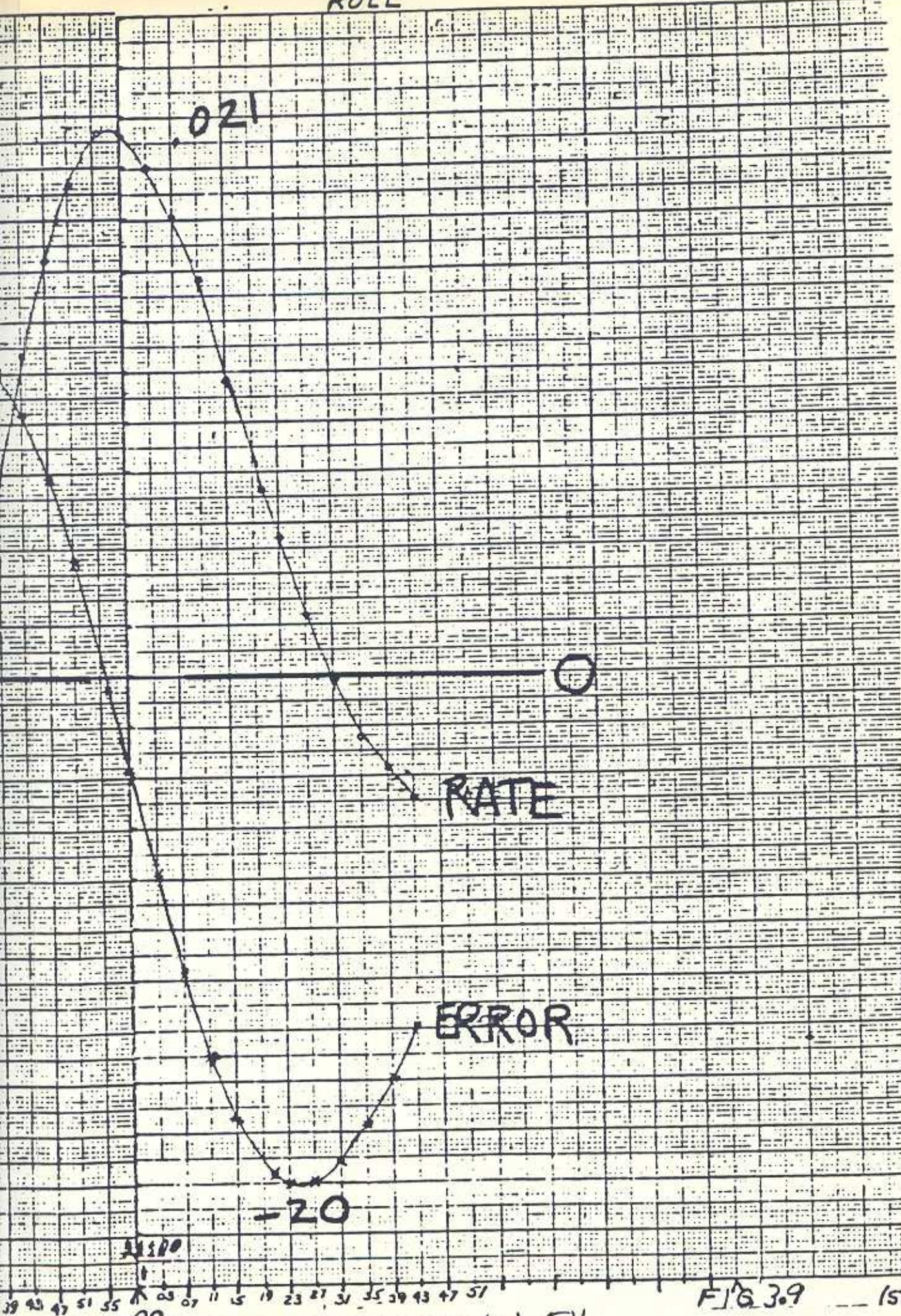
20:00

-25

18:00

27 31 35 39 43 47 51 55 59 63 67 69
25 29 33 37 41 45 49 53 57 61 65 69

ROLL



11500

-20

RATE

ERROR

39 43 47 51 55 00 03 07 11 15 19 23 27 31 35 39 43 47 51

FIG 3.9

15

6.1.54

PITCH

PITCH

REF ATTITUDE

$P = 357.51$

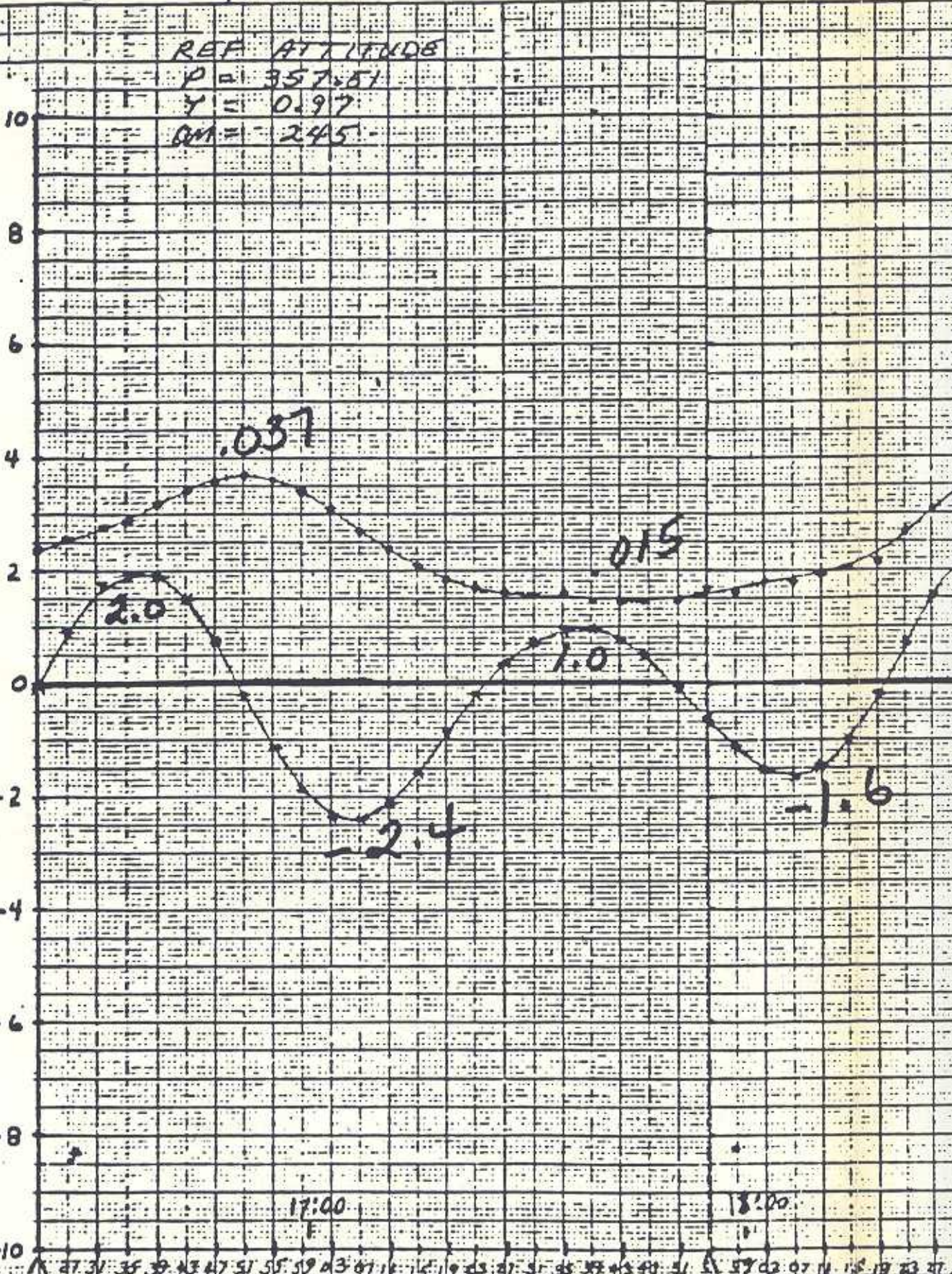
$\gamma = 0.97$

$GM = 2.45$

0 PITCH RATE deg/sec
* PITCH ERROR deg

10
8
6
4
2
0
-2
-4
-6
-8
-10

.1
.08
.06
.04
.02
0
-.02
-.04
-.06
-.08
-.1



17:00

18:00

179°16:23:00

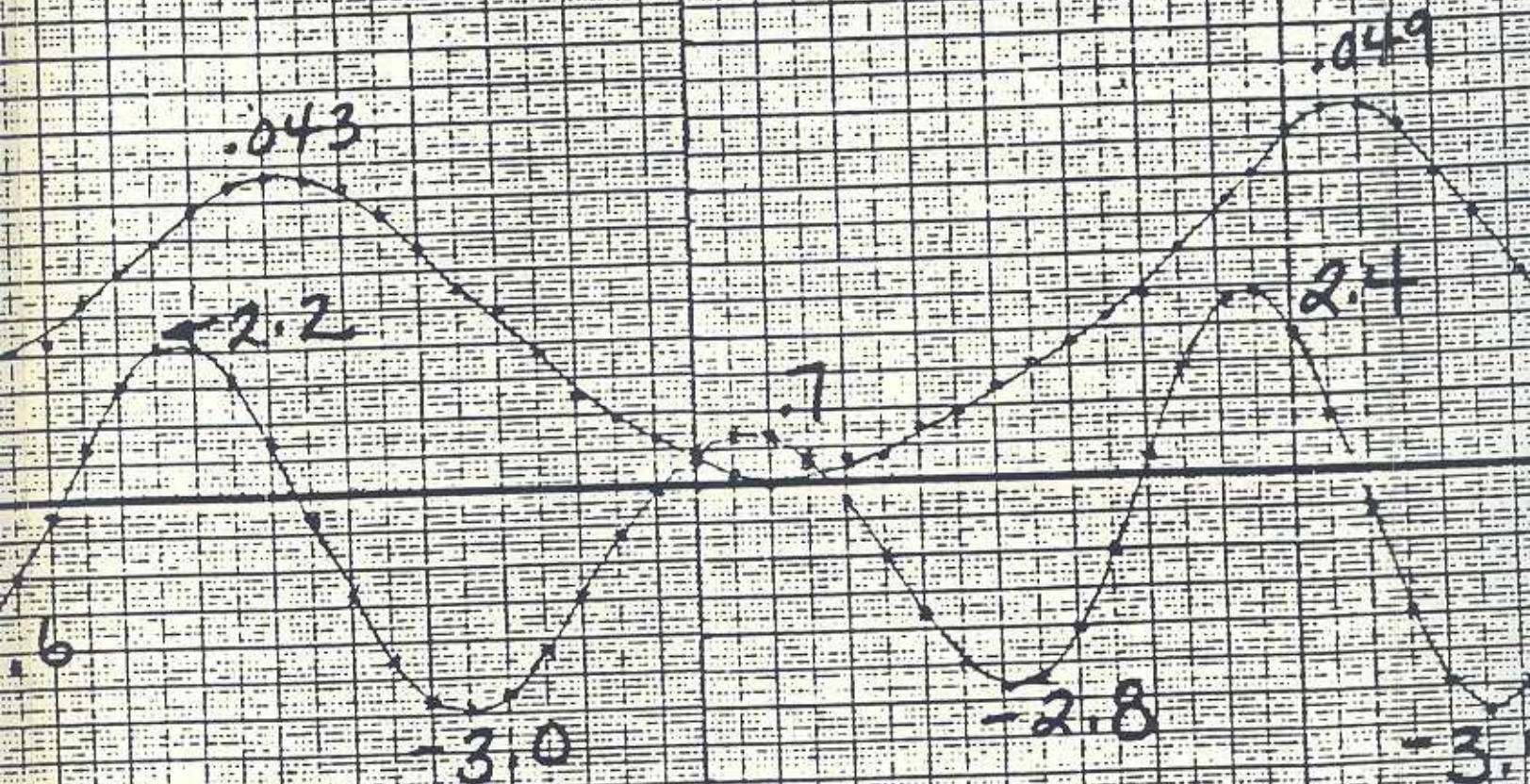
179P

START GMT

STOP

PITCH

PITCH



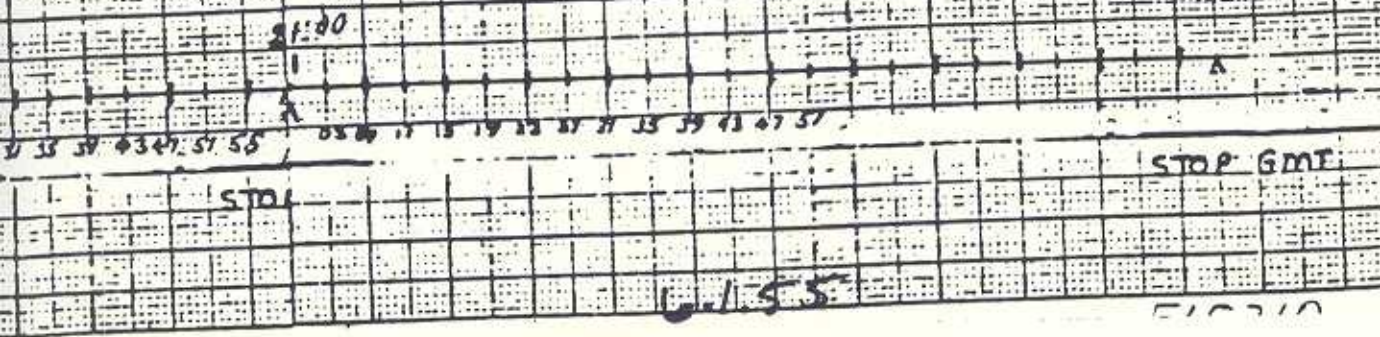
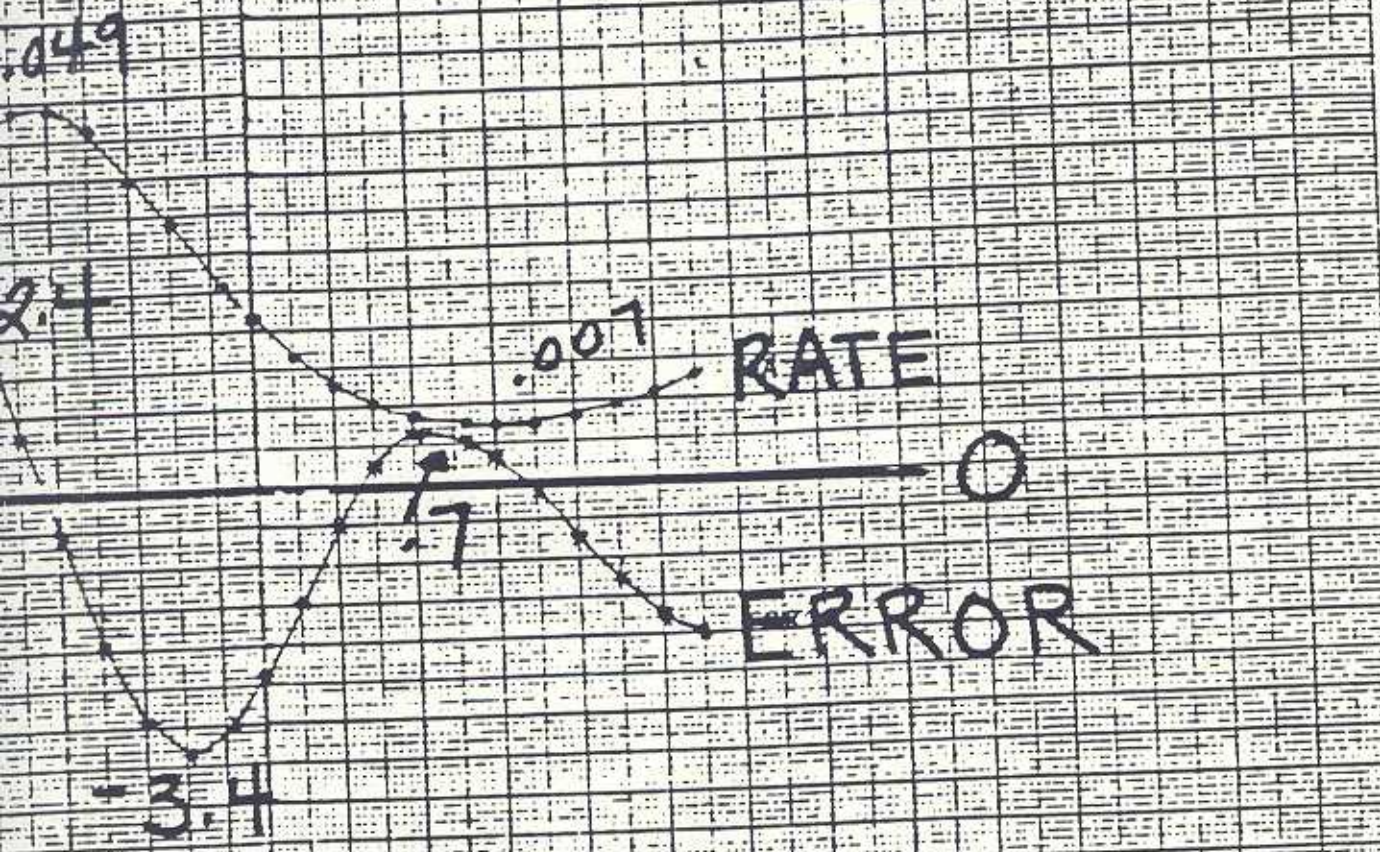
19:00

20:00

1 15 19 23 27 31 35 39 43 47 51 55 59 63 67 71 75 79 83 87 91 95 99 103 107 111 115 119 123 127 131 135 139 143 147 151 155 159 163 167 171 175 179 183 187 191 195 199 203 207 211 215 219 223 227 231 235 239 243 247 251 255 259 263 267 271 275 279 283 287 291 295 299 303 307 311 315 319 323 327 331 335 339 343 347 351 355 359 363 367 371 375 379 383 387 391 395 399 403 407 411 415 419 423 427 431 435 439 443 447 451 455 459 463 467 471 475 479 483 487 491 495 499 503 507 511 515 519 523 527 531 535 539 543 547 551 555 559 563 567 571 575 579 583 587 591 595 599 603 607 611 615 619 623 627 631 635 639 643 647 651 655 659 663 667 671 675 679 683 687 691 695 699 703 707 711 715 719 723 727 731 735 739 743 747 751 755 759 763 767 771 775 779 783 787 791 795 799 803 807 811 815 819 823 827 831 835 839 843 847 851 855 859 863 867 871 875 879 883 887 891 895 899 903 907 911 915 919 923 927 931 935 939 943 947 951 955 959 963 967 971 975 979 983 987 991 995 999

1791

STOI



YAW

YA

REF. ATTITUDE

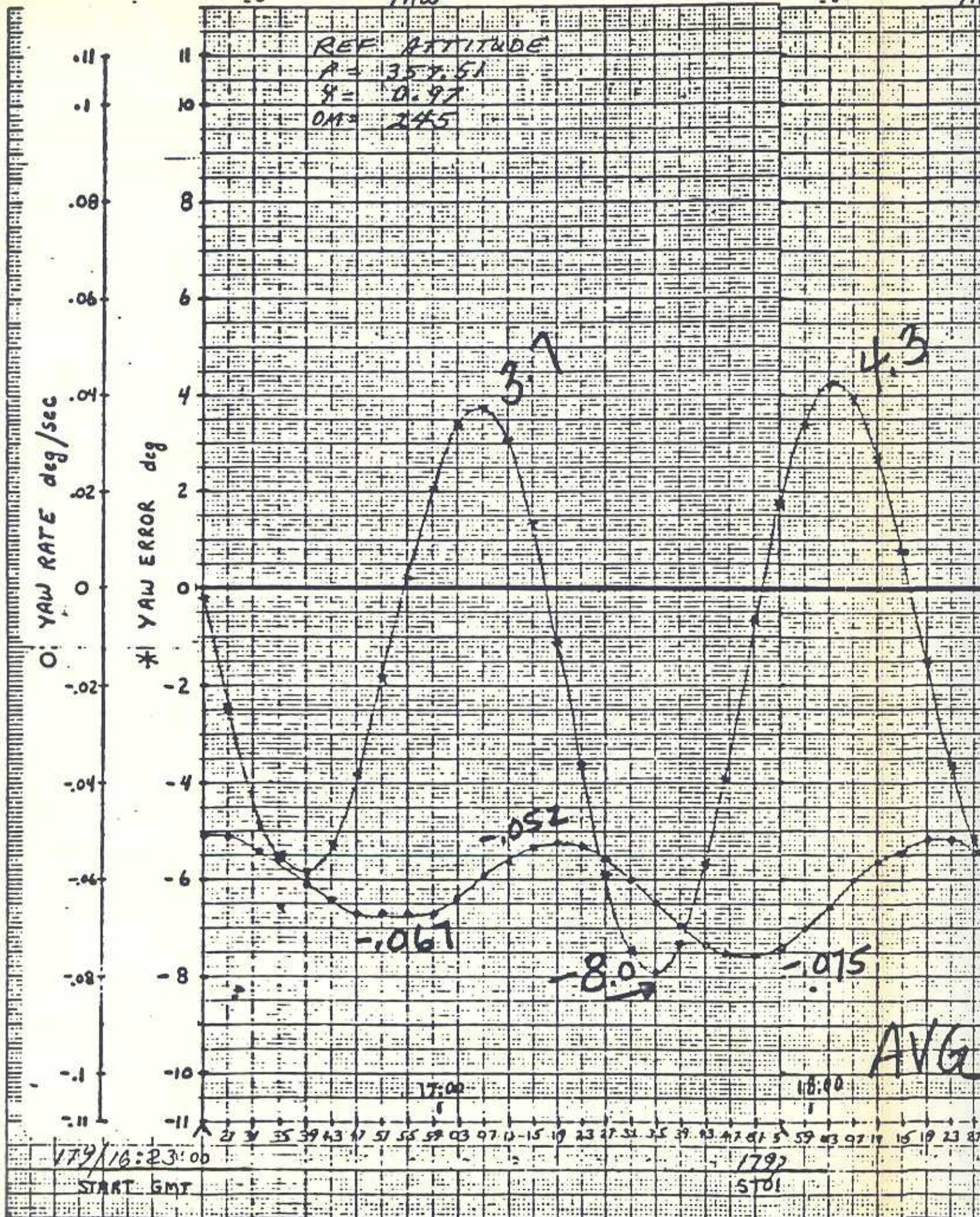
$A = 357.51$

$\delta = 0.97$

$OM = 245$

O: YAW RATE deg/sec

* YAW ERROR deg



AVG

179/16:23:00

START GMT

17:00

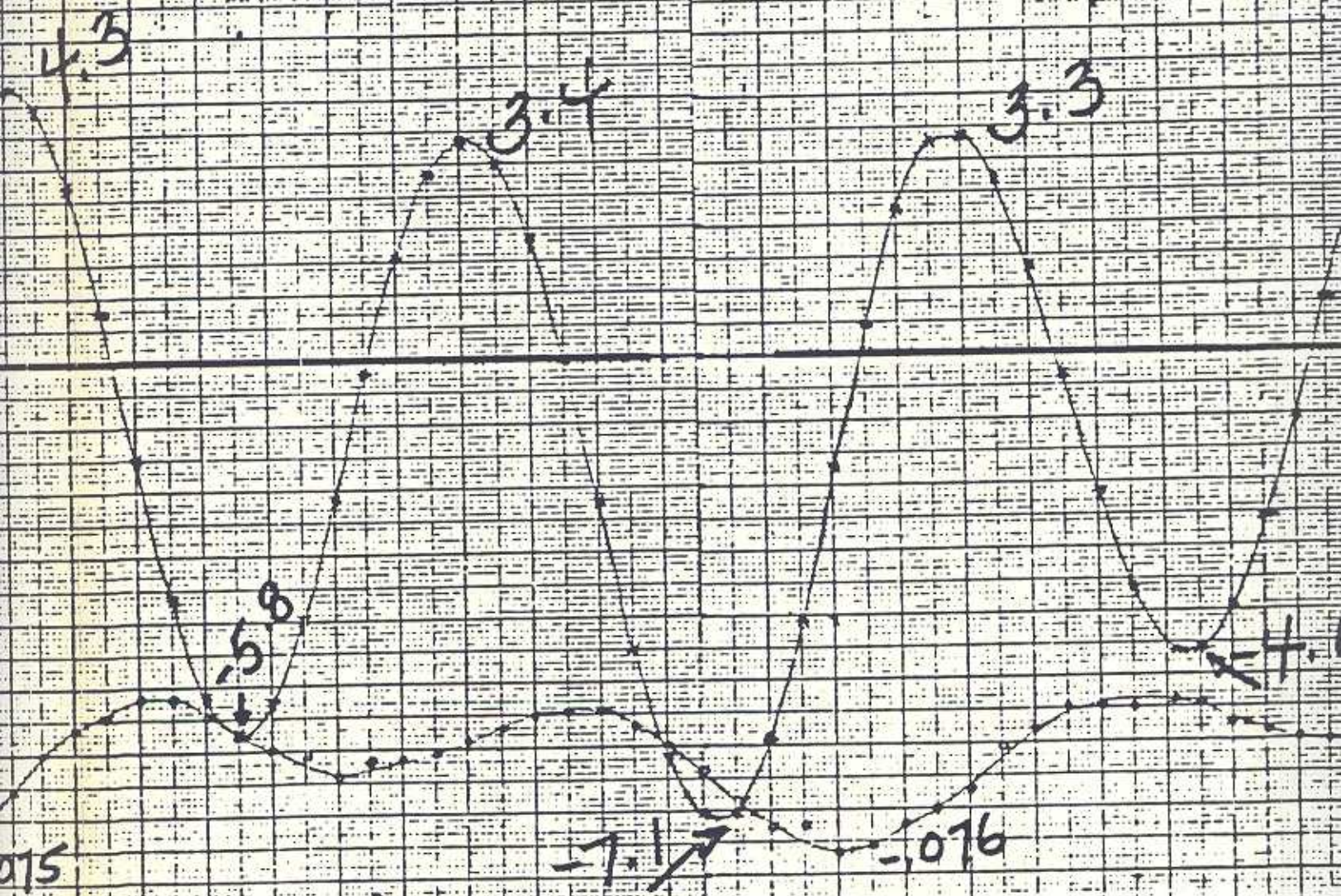
18:00

1792

5701

YAW

YAW

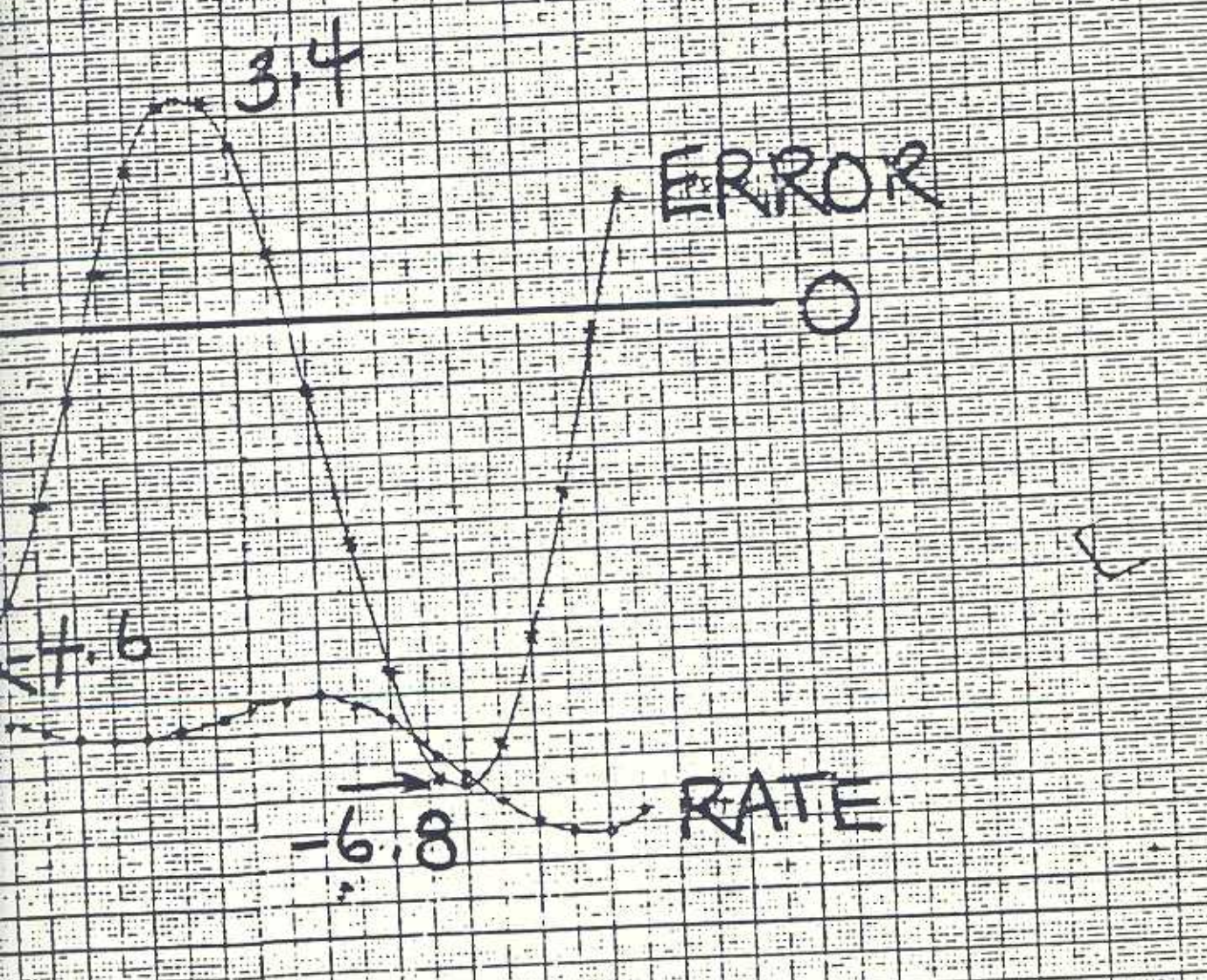


AVG RT = -0.065

00 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410

179
508

DAY TWO
YAW



23:00
35 38 43 47 51 55 59 03 07 11 15 19 23 27 31 35 39 43 47 51
STOP

6.1.56

4.0 DAP Performance

- 4.1 Introduction - The orbit DAP performed well the 6 days on-orbit. No software anomalies were noted. Some of the control parameters, namely maneuver rate and attitude deadband, caused an excessive amount of VRCS activity and prop usage. The resulting lengthy firings of L5D and R5D are probably the cause of tile damage located on the upper surface of the bodyflap. These control parameters should be changed (via crew input) for future flights as outlined in this report.

Also, a crew induced contact failure occurred which can be attributed to non-specific FDF terminology. The contact was determined to be functioning properly.

- 4.2 Tests Performed on the System - The only test performed relative to the orbit DAP was the PRCS narrow deadband test. A $.1^{\circ}$ deadband was used. Preliminary data indicates the PRCS system was able to control to this tight constraint. Several jet firings occurred in the 2 minute period. The prop usage has not been determined, but it will probably be high.

- 4.3 Anomalies - Strictly speaking, there were no DAP anomalies. There were, however, areas of concern:

- 4.3.1 Excessive VRCS Activity - This concern was expressed post STS-3 after a DAP maneuver rate of $.5^{\circ}/s$ was used in conjunction with a 1° deadband during several maneuvers. This combination caused unacceptable VRCS activity due mainly to phase plane overshoots. On STS-4 the rate was lowered to a maximum of $.3^{\circ}/s$. The resulting activity was still unacceptable. For example, during the RMS/PRCS test a $.3^{\circ}/s$ VRCS rate was used in conjunction with a 5° deadband after each PRCS doublet to take out the residual rates and return the vehicle to the desired attitude. Jets L5D and R5D had continuous ON times of 45 sec and 27 sec respectively. This activity must be considered excessive and illustrates the VRCS inability to effectively handle "high" vehicle rate demands.

In addition, several of the tiles on the upper surface of the bodyflap were damaged during the flight. The damage is believed to be due to L5D/R5D plumes.

The rate/deadband combination also induced excessive VRCS activity when DAP B2 was used for a maneuver. The rate was $.2^{\circ}/s$ and the deadband was $.1^{\circ}$. This rate is not considered excessive for the verniers, but the deadband is too small to allow phase plane capture without overshoots.

- 4.3.2 Transition Moding - On two occasions while expanding/collapsing the G2 redundant set, the VERN pb was not depressed during the OPS 201 PRO. In both instances the DAP upmoded to NORM. Since the RJDs were off erroneous jet fail offs occurred and the vehicle was in free drift. The problem is the failure of the FDF to be specific. That is, DAP is all that is called for following the 201 PRO. During another set expansion an erroneous contact fail occurred. This problem is described in paragraph 1.3.

4.4 Recommendations

- 4.4.1 Since the VRCS is so sensitive to rate demand, all maneuvers at a rate greater than $2^{\circ}/s$ should be done with the PRCS jets. RMS constraints must be recognized when using PRCS.
- 4.4.2 To avoid the situation where a maneuver is done with a DAPLOAD intended for an FTO, as was the case on this flight, it is recommended that DAP A be set up for maneuvers. Only DAP B should be reconfigured to support FTO and payload requirements. DAP A should be reconfigured only if a specific FTO or payload requirement demands repeated cycling between 2 different DAP loads. In such a case DAP A should be returned to the maneuver configuration as soon as possible. Flight crews can thus be trained to do all normal maneuvers in DAP A virtually eliminating the possibility of maneuvering in improper configuration.

Definition of the best DAP configuration for maneuvers is dependent upon propellant consumption, jet lifetime, and maneuver time. It is the subject of continuing analysis, but we recommend that until this analysis produces a better one the following configuration be used for DAP A.

	<u>RATE</u>	<u>DEADBAND</u>
NORM	$.5^{\circ}/s$	3°
VERN	$.2^{\circ}/s$	1°

There has been no consistent philosophy concerning DAP A/B management for the first four flights. Based on the events on STS-4 it is time to start.

ANOMALY	TIME	DESCRIPTION/IMPACT/RESOLUTION	ST
---------	------	-------------------------------	----

RMU-01	PRELAUNCH (L-1 DAY)	APPROXIMATELY 400 TILES SHOW SOME EVIDENCE OF HAILSTONE IMPACT DUE TO HAIL THAT OCCURRED ON PAD DURING THUNDERSTORM. TILES AFFECTED ARE LOCATED ON RH OUTBOARD BOTTOM WING AND ELEVON, RUDDER/SB AND VERTICAL STABILIZER. MANAGEMENT DIRECTION IS TO REPAIR TILE THAT CAN BE ACCESSED IN TIME AVAILABLE AND NOT DELAY LAUNCH. TPS TEAM HAS REVIEWED LAUNCH FILM AND REPORTS NO TILE IMPACT OR TILES LEAVING VEHICLE.	CL
--------	---------------------	--	----

DUE TO THE TILES BEING SOAKED WITH RAIN THE ATTITUDE TIMELINE WAS ALTERED GOING TO A BOTTOM-SUN ATTITUDE FOR APPROXIMATELY 24 HOURS TO "BAKE OUT" THE TILES AND REMOVE ANY WATER THAT COULD FREEZE WITHIN THE TILE AND CRACK THEM. AFTER APPROXIMATELY 16 HOURS IN BOTTOM-SUN THE TILES APPEARED TO BE DRY. THE ATTITUDE WAS CONTINUED IN ORDER TO MEET THE THERMAL DTO REQUIREMENT OF APPROXIMATELY 34 HOURS OF BOTTOM-SUN.

GNC-01	178/0653	IMU 3 AZ GMEL DIDN'T CAGE AT POWER UP. SUSPECT STUCK RELAY. NO IMPACT SINCE CAGING NOT REQUIRED IN FLIGHT.	CL
--------	----------	--	----

ANOMALY	TIME	DESCRIPTION/IMPACT/RESOLUTION	ST
PROP-01	178/0730	L OMS FU TK PRESSURE C&W LIMIT: OMS POD HOT AIR PURGE RESULTED IN L OMS FU TK PRESSURE READING 1 PSIA LESS THAN THE HARDWARE C&W AND BFS SOFTWARE LIMIT OF 288 PSIA. KSC STATED THAT DECREASING THE TEMPERATURE OF THE HOT AIR PURGE WAS NOT AN OPTION. CONSEQUENTLY, A BFS GMEM PROCEDURE HAS BEEN WRITTEN TO ADJUST THE TK PRESS UPPER LIMIT. THE GMEM WILL NOT BE UTILIZED UNLESS THERE IS A POSSIBILITY OF VIOLATING THE PRESENT UPPER LIMIT DURING PRELAUNCH AND ASCENT OPS. GMEM CHANGES SOFTWARE LIMIT FROM 288 PSIA TO 290 PSIA. HARDWARE C&W HAS ALREADY BEEN CHANGED TO 296 PSIA. NO BFS UPDATE WAS REQUIRED AND CREW CHANGED HARDWARE C&W BACK TO 288 PSIA AT MET 0/.045.	CL
GNC-02	178/1020	TACAN 2 BEARING CHANNEL SHOWS CYCLIC OSCILLATION OF ABOUT 25 DEGREES. KSC ADVISED BUT PLANS NO ACTION. TACAN 2 BEARING CONSIDERED SUSPECT. WILL EVALUATE WHEN PERFORM DTO'S AND SELF TEST. TACAN 2 PASSED SELF TEST. OK FOR USE. GUIDANCE & GNC REPORT TACAN 2 BEARING SOLID DURING TACAN TEST.	CL
PROP-02	178/1343	KSC OBSERVED WATER LINE MARK ON PAPER COVERS FOR F1L, F3D, F1F, F2F, F3F. LAUNCHED WITH THIS CONDITION. F3D, F1F SHOWED INDICATIONS OF WATER IN THE CHAMBER AS EVIDENCED BY INJECTOR TEMP COOL DOWN DURING ASCENT. NO JET PROBLEMS OBSERVED DUE TO WATER IN THE CHAMBER.	CL
EECOM-01	178/1409	THERMAL EVAP MSG CAUSED BY TEMPORARY FREEZE IN ASCENT. CLEAR NOW.	CL

ANOMALY	TIME	DESCRIPTION/IMPACT/RESOLUTION	ST
GNC-03	03/2125	RM HAS DESELECTED CONTACT A ON FWD DAP AUTO PUSHBUTTON. NO IMPACT AT THIS TIME. IF ONE OF THE OTHER TWO CONTACTS WERE TO FAIL, WOULD NOT BE ABLE TO SELECT AUTO FROM FWD STATION. MEMORY READ/WRITE IS IN WORK TO RE-GAIN THIS CONTACT IN RM SOFTWARE. THE RM FAILURE, WHICH HAPPENED DURING AN OPS TRANSITION, LOOKS LIKE A TRANSIENT, SINCE THE SWITCH SUBSEQUENTLY SHOWED 3 GOOD CONTACTS. MEMORY READ/WRITE WAS DISAPPROVED. IF GET ANOTHER FAILED CONTACT, CREW WILL FLY MANUAL TRANS DAP (OR MM301 THROUGH MM303).	CL
RMU-08	03/2155	APU NO. 3 SEAL CAVITY DRAIN PRESSURE IS DECREASING IN "STEP DROPS" SPREAD OVER SEVERAL HOURS. THE EXACT MECHANISM IS NOT UNDERSTOOD BUT IS NOT CONSIDERED ANY IMPACT TO PROCEDURES OR ENTRY. ON STS-3, APU SEAL DRAIN PRESSURE DROPPED COMPLETELY TO ZERO PSIA WITH NO SUBSEQUENT PROBLEMS.	CL
PROP-08	04/0411	R5D FU INJECTOR TEMP BIASED 25 DEGREES LOW. SAME CHARACTERISTICS AS F5L (REF. PROP-06 ANOMALY). NO IMPACT.	CL
EECOM-06	04/1655	EECOM CONFIRMED PCS #2 N2 LK AT LOW TEMPERATURES (<50 DEGREES) INTO VACUUM VENT LINE. LK RATE IS APPROXIMATELY 3 LBS/HR. SWITCH TO SYSTEM 1.	CL

Statement of problem: Orbital DAP (Digital Autopilot) control auto select switch contact "A" failed.

Discussion: During STS-4, the contact "A" of the forward orbital DAP (digital auto pilot) control auto select pushbutton switch (switch 3 on panel C3A6) contact "A" failed when the switch was activated. Subsequent activations indicated the contact had cleared, however, the RM (redundancy management) flag remained latched as there is no preprogrammed reset capability for this switch. The problem was duplicated after the flight by slowly depressing (teasing) the switch while monitoring the output of each contact. One or two contacts could be activated while the other(s) remained open. This is normal operation for this type of switch. The crew reported that extra care was necessary to insure that firm pressure was applied to push button switches while in zero g.

A switch review showed that the orbital DAP control auto and manual select switches are the only three contact push button switches used in zero g without a backup or item reset capability. A software change is being requested to provide backup switch capability during entry phase or to clear the RM flag if it remains latched.

Conclusions: The contact failure was caused by applying gentle pressure to the switch during zero g operation.

Corrective action: The crew will insure that firm pressure is applied to all pushbutton switches for proper operation during zero g. A software change is being requested to provide either backup or reset capability for the orbital DAP control auto and manual pushbutton select switches. Fly as is for STS-5. Implement the Software Control Board decision for future flights.

APPROVED

for A. Aldrich

R.M. Hermon 8/31/82

Date

Effect on subsequent missions: None.

Personnel assigned: A. J. Farkas/EH5; R. J. Ward/WA3

Resolution: CLOSED 09/01/82

Statement of problem: Upper Body Flap Tile Degradation Caused by Aft Vernier RCS Plumes.

Discussion: The orientation of the two aft vernier RCS thrusters results in direct plume impingement on the upper body flap tiles. High aft vernier usage during STS-3 and STS-4 caused degradation of the HRSI (high temperature reusable surface insulation) tiles on the upper body flap. Erosion or roughening of the tile surface was first noted after STS-3. Accumulated degradation during STS-4 resulted in severe erosion of several tiles on the upper surfaces of the body flap.

Testing indicates that RTV (room temperature vulcanizing) material will still be elastic after ascent and should provide adequate protection from the thruster plumes. Verification of RTV-coated tiles is planned at White Sands on August 20, 1982, during thruster life testing. An AFRSI (advanced flexible reusable surface insulation) blanket will also be tested as a long-range solution.

Conclusions: High usage of the two aft vernier RCS thrusters resulted in continued degradation of HRSI tiles on the upper surfaces of the body flap and tile refurbishment or replacement was required.

Corrective action: Nine tiles on the upper left body flap and three on the upper right have been coated with RTV. One tile on the upper left has been replaced. Potential long-term solutions include thruster re-orientation, scarfing or plume deflectors for the aft vernier thrusters as well as an AFRSI blanket for the upper body flap tiles. FOD will limit vernier RCS usage to under 0.2°/second rates.

APPROVED

[Signature]
A. Aldrich

8-23-82

Date

Effect on subsequent missions: None. Repair and/or replacement of several upper body flap tiles may be required after each flight until a long range solution is implemented.

[Signature] 8/18/82 *[Signature]* 8/18/82

Personnel assigned: R. L. Dotts/ES3; R. J. Ward/WA3

Resolution: CLOSED for STS-5 08/25/82