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17 September 1963

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CORONA J FLIGHT REPORT

FTV 1162 - SYSTEM J1 -1001

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Requirements & Analysis

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SUMMARY

Flight Test Vehicle 1162 was a S-01A orbital stage employing a SLV-2 booster. The primary payload aboard was J1, a dual recovery reconnaissance camera system, consisting of panoramic cameras 114 and 115 and stellar index cameras D14/15/14 and D16/16/16.

A four day camera operational mission followed by a five day on-orbit storage period and a second camera operational mission of three days was programmed.

Launch occurred at 5:30 P.M. PST on 24 August 1963. Ascent and injection into orbit appeared normal in all aspects. A comparison between the predicted and actual orbital parameters for the first mission is included as Table I.

TABLE I

ORBITAL PARAMETERS

Parameter	Predicted	Actual
Period (Minutes)	90.67	90.54
Apogee (N. M.)	235.6	236.91
Perigee (N. M.)	99.65	99.77
Eccentricity	0.0189	0.019
Inclination (Degrees)	75	75.03
Perigee Latitude	23.2	48.12

The first phase of the mission was completed on 28 August 1963 and a successful air-catch recovery was made of the first recovery system on orbit 65. The vehicle was deactivated on orbit 70 and the on-orbit

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storage period appeared successful. Reactivation was commanded at the end of the fifth day of on-orbit storage (orbit 149). However, the second phase of the mission was unsuccessful due to a failure in the 400 cycle single phase amplifier which precluded vehicle restabilization and instrument operation.

The recovery of the second capsule was attempted on orbit 192 and was unsuccessful.

The payload system operation, as determined from telemetry and tracking data, is discussed in the following sections of this report.

INSTRUMENTATION AND COMMANDING PERFORMANCE

A single two-ring commutator was used to modulate two telemetry channels; one for temperature data and the other for payload status monitors. On orbit 41 this commutator failed to run during the [redacted] acquisition but started running during the acquisition at [redacted]. No further problems were experienced in the first mission. During the second mission the two channels were clipped above the three volt signal level. This clipping was intermittent between orbits 149 and 160. The commutator failed completely on orbit 160. This clipping does not appear to be a mode of failure of a commutator, however, the commutator and transmitter are the only two items common to both telemetry channels in the data link.

All real time commands issued were verified and executed with the exception of command 11 issued on orbit 158. Two commands were reportedly issued, however three were executed. No explanation is available for this anomaly.

No other instrumentation or commanding problems were evident.

CAMERA SETTINGS AND FILM TYPES

Panoramic Cameras:

	Master	Slave
Film Type	S0132	S0132
Slit Width	0.200 In.	0.200 In.
Filter Type	Wratten 21	Wratten 21

Horizon Optics:

	Master	Slave
Aperture	F6.8	F6.8
Exposure Time	1/100-Sec.	1/100-Sec.
Filter Type	Wratten 25	Wratten 25

Stellar Index Settings:

	Stellar Index A		Stellar Index B	
	Stellar	Index	Stellar	Index
Film Type	S0102	S0130	S0102	S0130
Aperture	F1.9	F4.5	F1.9	F4.5
Exposure Time	2Sec Nom.*	1/500-Sec.	2Sec. Nom.*	1/500-Sec
Filter Type	None	Wratten 21	None	Wratten 21

* = Dependent on cycle period of Master Camera

[redacted]

PANORAMIC INSTRUMENT PERFORMANCE (A MISSION)

The dynamic performance appeared normal on all engineering passes monitored on telemetry. The cycle periods were within 1 percent of the preflight nominals at the bottom of the v/h ramp and within ½ percent at the top of the ramp for the slave instrument. The master instrument ran approximately 1 percent slower at the bottom and ½ percent slower at the top of the ramp than the slave instrument.

A lens stow experiment was conducted on orbit 11 over the [redacted] tracking station. The v/h programmer had not started at the time of the operation. The cycle period was 5 sec./cycle and both lenses stopped just beyond the home position but well within the safety zone.

Vehicle attitude data during the engineering operation on orbit 47 is included as Enclosures 1 and 2. No attitude perturbations are evident in these data. No instrument dynamic problems were evident in the data during the first mission.

PANORAMIC INSTRUMENT OPERATION (CUT AND WRAP)

The cut and wrap operation was performed without real-time telemetry coverage. The cassette rotation monitor and the payload status commutator were tape recorded and played back at the next telemetry acquisition.

The cycle counters indicated the master instrument completed four cycles and the slave instrument completed three cycles. The slave instrument cassette rotation monitor indicated correct cassette take-up during the complete operation. The master instrument cassette rotation monitor indicated the initial cassette rotation at arm was normal but that subsequent instrument cassette rotation was abnormal. Three possible causes are:

1. Hangup of film in the film path
2. Incorrect operation of the Cassette
3. Intermittent monitor switch

Several cut and wrap tests have been conducted and inspections have been made of a cassette and the cut and wrap sequence. As a result of these tests, the most probable failure mode appears to be an intermittent monitor which could have been caused by either a faulty switch or an incorrect switch adjustment. Enclosure 3 is the analog record of the telemetry playback showing the multiplexed waveform and the waveform of each cassette along with a waveform that was constructed using a ratio derived from the differences in speed of the two cassettes in completing the first rotation. Other test data has also been compared with the in-flight data all of which point toward an intermittent monitor.

All other cut and wrap switchover functions appeared normal.

PANORAMIC INSTRUMENT OPERATION (B MISSION)

As a result of the loss of 400 cycle power, the payload system was unable to operate during the second mission. However, the instrument system was commanded on in mono mode on orbit 151 and to stereo mode on orbit 157 then off on orbit 160. The on command caused the operate relays to latch and stay latched awaiting the instrument system to complete at least one cycle.

This caused a power drain of approximately 6 amps by the system in the stereo mode. This excess power drain stopped during the acquisition at the [redacted] tracking station on orbit 168 indicating the instrument system had possibly cycled. This was impossible to verify due to the failure of the commutator. The cycle counters did indicate the slave instrument completed two cycles on orbit 159. It has been noted in test that the instrument system will creep without the 400 cycle power if the transistor in the output of the magnetic amplifier leaks.

No other instrument problems were evident in the limited data available.

STELLAR INDEX PERFORMANCE

The stellar index camera operation appeared normal for the engineering passes on orbits 9 and 25. However, a failure was apparent in the data for orbit 47. Data for this pass indicated the index shutter opening was out of synchronization. This condition has been attributed to an incorrect adjustment in the shutter wind clutch and has been duplicated in testing. The platen up command caused the clock to be interrogated giving serial outputs on passes 9 and 25.

CLOCK PERFORMANCE

The clock performance appeared normal throughout the flight with the accuracy within the reading tolerance of the data. One anomaly did occur on an engineering pass. The clock serial output was only six bits long. This has also been noted in testing several times but apparently has no effect on the performance or accuracy of the clock system.

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THERMAL ENVIRONMENT

Thermal data were tape recorded throughout the active portions of the flight. Enclosures 4 thru 19 are plots of the thermal data which are representative of the indicated thermal environment. Enclosures 20 thru 26 show temp sensor locations. As evidenced by the enclosed plots, data were acquired in sufficient quantity, continuity, and repeatability to define an indicated thermal environment through first recovery. Data for the second active phase of the mission have been processed but not analyzed at this time.

Correlation between the various monitors established a high degree of consistency; i.e. random errors in the calibration of various monitor circuits are small. As an example, refer to Enclosures 16 and 17 which are, respectively, plots of the fourth power time average barrel no. 2 skin temp sensors vs position in degrees and vs position along the barrel diameter between the points of maximum and minimum skin temperature. The curve of the first plot is characterized by symmetry on either side of the shadow line. The curve of the second plot is a nearly linear curve which has no inflection point. Both of these curve shapes are of the form that should be expected of the thermal gradient along the skin. Note that in all cases the data points fall almost exactly on the curves. This fact establishes a very low degree of random errors in the aft barrel skin temp monitor circuits. The establishment of negligible random errors, however does not establish the validity of the absolute values of the data although it does establish the validity of temperature differentials between the monitors. The validity of the absolute values indicated by the data can be established only through continuous engineering analysis of systematic errors in the instrumentation system coupled with analysis of data from repeated flights of essentially the same hardware/instrumentation system.

All data parameters were quantified using nominal circuit resistor values and the nominal manufacturing calibration curve for the type transducer used. Individual circuit calibrations were not performed. Three one point systems checks were available for the instrument temperature sensors only and were incorporated into the final calibrations used for quantification of the flight data. Two system checks were performed by Boston prior to shipment of the instrument at a reported 70°F ambient temperature. The average indicated temperature for this system check was approximately 82°F. The AP acceptance test was performed in the J clean room at approximately 70°F ambient; the average indicated temperature was approximately 80°F. On the basis of these three one point system checks, the calibrations of all instrument temp sensors were normal shifted down 10°F. There were no valid one point checks available for the skin temp sensors; consequently, the nominal calibration curves without normal shift were used to quantify the flight data. No one point checks were available for the clock temp sensors, the S/I temp sensors, or the supply cassette temperature sensors which had validity equal to those used to normal shift the instrument temperature sensor calibrations. However, during the pad run, although ambient temperature varies along the skin of the payload, the supply cassette, stellar index and clock

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temperatures are expected to be consistent with other internal temperatures. Pad run data indicated the supply cassette, clock and stellar index temperatures were approximately 10°F high with respect to the instrument temperature sensors using the normal shifted curves. On this basis, the clock, stellar index and supply cassette temperatures were normal shifted down 10°F as were the instrument temp sensors. The lack of any valid system checks for the skin temperatures, which are a different type of transducer from the internal temperature sensors, establishes a possible system bias error between external and internal temperatures; however, the lack of such checks in no way proves that such system biases exist. It is felt that the calibrations used to quantify the data represent the most accurate curves that were available at the time of launch. As pointed out previously, the true validity of the absolute values of the data can be accurately established only through analysis of future J flights and continued analysis of the temperature instrumentation system.

An attempt was made to analyze the flight data and establish indicated empirical relationships which could be used for predicting thermal conditions once such relationships were confirmed by future J flights. Enclosure 19 presents a cross plot of the internal temperatures vs external temperatures along the barrel diameter across the points of minimum and maximum skin temperatures. The slope of this curve indicates that the internal temperature gradient is .3 of the skin thermal gradient. For J-1 there was an average skin temp gradient of approximately 174°F and an internal temperature gradient of approximately 53°F. This plot, if proven true by future flight data, can

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be used to predict internal temperatures based on predicted skin temperatures for the J configuration vehicle. At present, prediction of internal temperature is the result of two theoretical math models, one used for predicting the skin temperature, and the other for predicting internal temperatures as a function of the results of the first prediction. Establishment of a high degree of validity of this empirical relationship could contribute to the theoretical predictions for the design of the thermal control system and result in more accurate thermal control.

Enclosures 27 and 28 are tabulations of real time temperatures obtained from telemetry data during the flight.

2. The J system has a variable mission life (up to 30 days) and could experience a broad range of orbital thermal environment (β). Preflight temperature predictions were confined to two extreme β conditions. Temperature predictions for intermediate β conditions or at β values beyond the bounds analyzed are assumed to be attainable by interpolation or extrapolation. The two conditions analyzed are:

1. $\beta = 53^{\circ}$, h = 150 s.m., No. 1 and No. 2 SRV attached
2. $\beta = 0^{\circ}$, h = 150 s.m., No. 1 SRV removed

Enclosures 29 thru 36 are plots of predicted temperatures based on the above.

In the first condition average main plate temperatures are predicted to approximately 77°F and time-average fourth power skin temperatures ($\overline{T}$) were predicted to be 111°F. In the second condition corresponding predictions were approximately 66°F and 76°F respectively.

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The β range experienced during the J-1 mission was from 61° on day 1 to 43° on day 10. Therefore, to assess the accuracy of skin temperature predictions, it is necessary to consider the actual flight β. On this basis, day 1 skin temperatures are predicted to be, $\overline{T}$ = 118°F. The $\overline{T}$ of the aft barrel for orbit 8 was computed from flight test data to be 123.1°F. The exterior thermal mosaic used on J-1 indicated skin temperatures within 3°F of nominal predictions. Therefore, it appears that the empirical method (-30°F bias using nominal optical properties for exterior surfaces) resulted in very accurate skin temperature predictions.

Flight data from day 1 indicates average main plate temperatures to be approximately 97°F. It would appear that the 20° difference between flight test data and predictions is the result of poor agreement between the mathematical thermal model and the physical system. A possible cause would be stronger thermal coupling, than expected, between the camera subsystem and the skin. This explanation can be additionally supported by considering main plate cross gradients in comparison with preflight predictions. However, another factor to be considered is the optical properties (α/ϵ) of the drum. A simplified expression to describe the equilibrium temperature of the interior mass shows that the drum temperature (and its optical properties) has as much influence on the interior temperature as the skin temperatures. Before final conclusions can be stated regarding camera subsystem orbital temperatures, two anamolies must be further investigated; i.e. the supply cassette temperature indicated approximately 78°F and was predicted to be 78°F, and the real time read out data on orbit 191 indicated an average instrument temperature of approximately 78°F and was predicted to be 78°F.

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RECOVERY SYSTEM PERFORMANCE

First Recovery

A successful air catch recovery of the first recovery system was made on orbit 65 on 8/28/63. The recovery system retro events were not acquired on telemetry. The parachute deployment events appeared normal and within tolerance. The condition of the recovered capsule was satisfactory with damage limited to normal paint blistering.

Second Recovery

Second mission capsule recovery attempt was made on orbit 192 and was unsuccessful.

The capsule separated and was acquired on telemetry by the recovery force near Hawaii indicating successful separation of the fairing assembly and retro events. No parachute deployment events were monitored and the capsule apparently impacted intact. Enclosure 37 is a plot of the telemetry data acquired.

Analysis of the recovery aircraft reports and the telemetry data indicates the batteries were apparently weak at the time of recovery preventing the normal recovery events from occurring. This can be partially attributed to the length and thermal environment of the storage period (21 days) between battery activation and recovery. Enclosure 38 is a plot of the on orbit temperatures encountered by the cassette which approximates the battery temperature. Enclosures 39, 40 and 41 indicate the ampere-hour loss and the allowable orbital

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life versus temperature for the battery used.

The excessively high cassette temperature experienced on the second mission is a result of the 400 cycle failure which caused the instrument system operate relays to remain in the latched position. This applies power to the cassette motors which are then in a stalled condition until the instrument system cycles. Under these conditions the cassette dissipates 14 watts in the mono mode and 28 watts in the stereo mode. This power dissipation caused the recovery system temperatures to rise.

ORBIT ANALYSIS

A profile of altitude over the area of interest as a function of time from launch is shown in Enclosure 42. The altitude was essentially as predicted, after allowance for the abnormally high 25° northward shift in the location of perigee.

The reduction in altitude as a result of period decay was also close to nominal, although as Enclosure 43 shows, the apparent rate of decay in period during the tumble mode was slightly greater than predicted so that the period at time of reactivation on rev. 149 was about 12 seconds less than the nominal value. There were no serious effects on orbit lifetime resulting from this greater decay since predictions at the end of the sixth day of tumbling showed an additional ten days of tumbling life remaining (equivalent to about thirty days of stable life).

At time of attempted reactivation on rev. 149 the period had decayed [illegible] a point where the orbit was in an approximately eight-day synchronous condition (seven days equally-spaced) and hence the potential coverage in

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the $2\frac{1}{2}$ days programmed was limited, although not greatly less than the nominal condition which would have been approximately six or $6\frac{1}{2}$-days synchronous. The orbit apparently would not have decayed to the one day synchronous condition until about the time of its demise.

Accurate data for predicting ground tracks during the unstable period were not available until $1\frac{1}{2}$ days after deactivation. These data are used for planning purposes in selecting the reactivation pass and selecting the best of the ten alternate programs for coverage. The delay was due to the limited tracking data available during the deactivated period. However, the errors in prediction resulting from the differences in decay between a stable and a tumbling vehicle do not become excessive (that is, outside the limits of the half the distance between the alternate programs) until about the third day after deactivation. Therefore, this delay caused no great difficulties and resulted in no change in the rough planning factors for selection of the reactivation pass and program, even though the plots for ground track showed marked changes between the stable and tumbling vehicle data.

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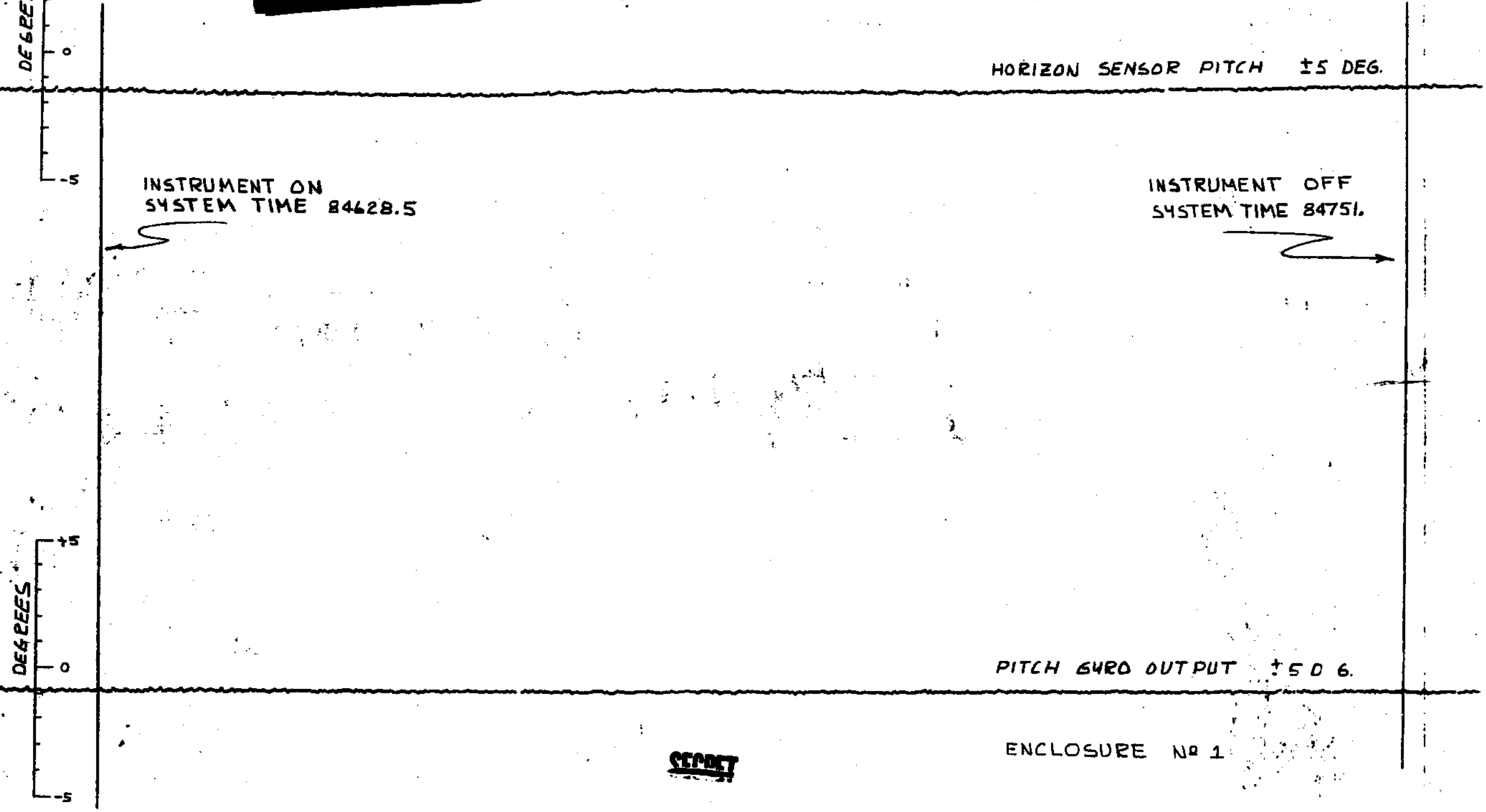
ATTITUDE DATA
VEHICLE 1162 MISSION 1001
ORBIT 47[redacted]



ENCLOSURE Nº 1

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[redacted]

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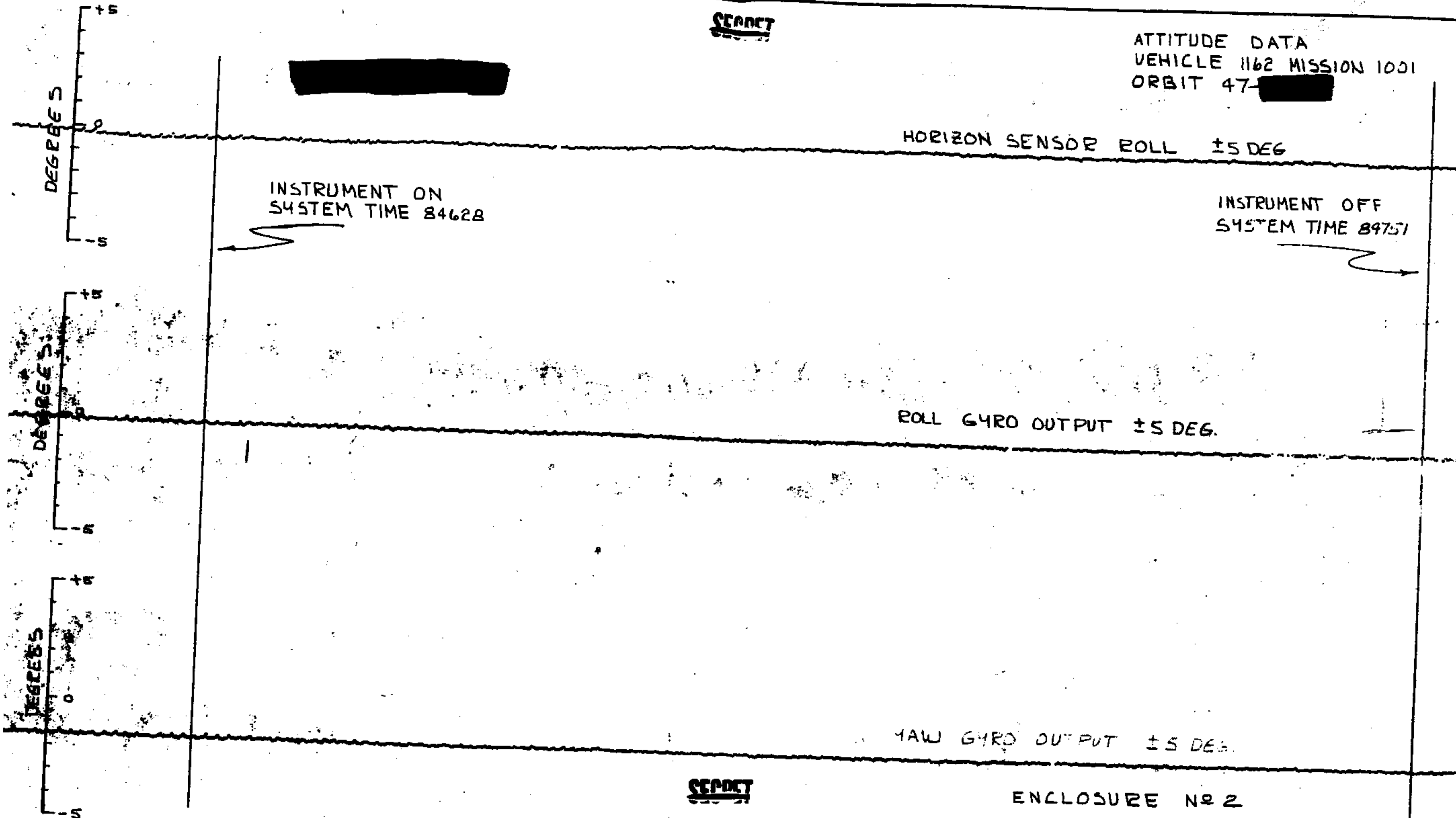
ATTITUDE DATA
VEHICLE 1162 MISSION 1001
ORBIT 47-[redacted]

[redacted]



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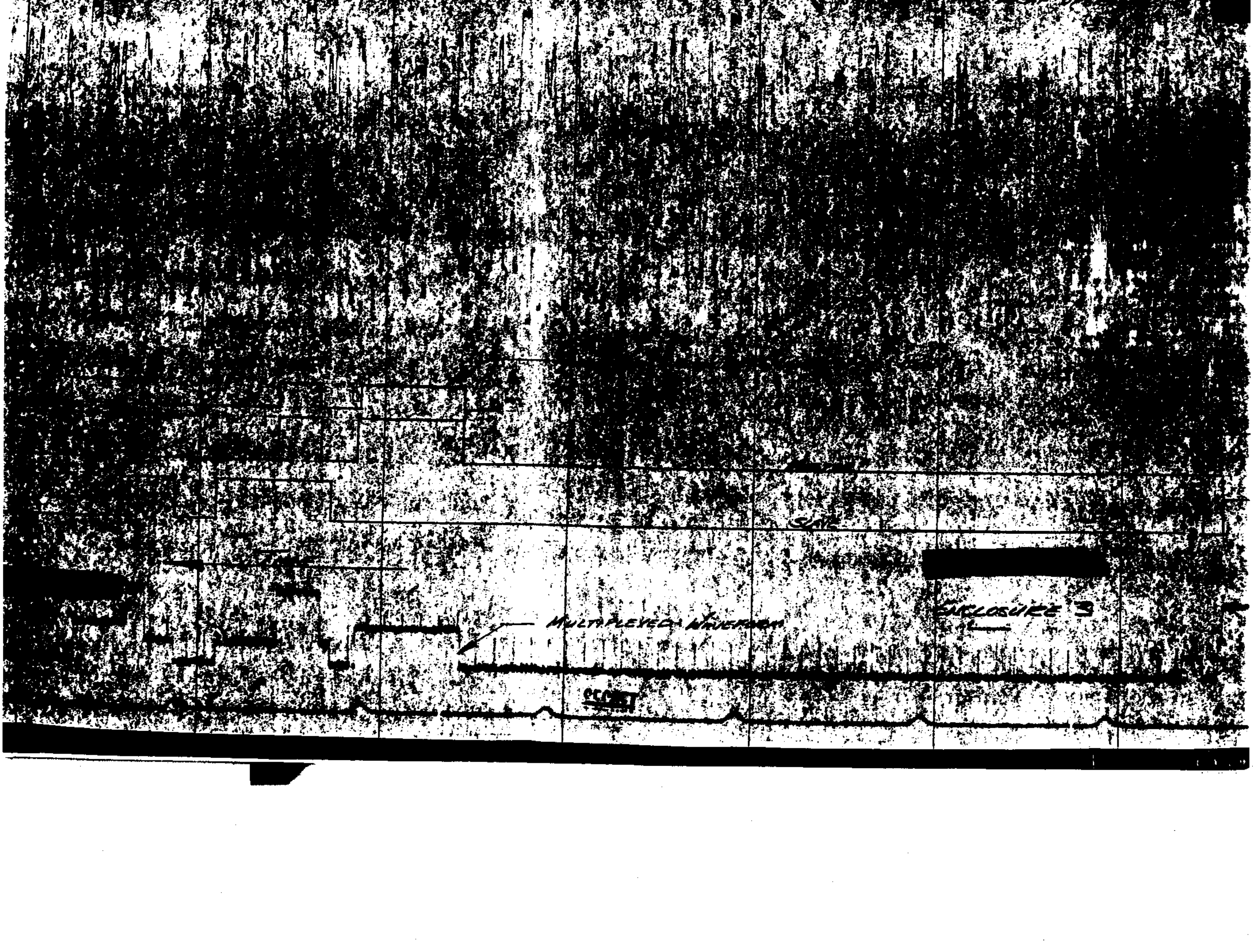
ENCLOSURE № 2

[redacted]


[redacted]
ENCLOSURE 3
MULTIPLEXED WAVEFORM