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APOLLO 15  
LUNAR SURFACE MAGNETOMETER FAILURE

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1.0 Summary

The LSM experiment data output became invalid at 15.07.33 hours on 10 December 1973. The data indicated "all ones". There have been spasmodic attempts by the experiment to output data since the original failure occurred, but none of the data has been valid.

Evaluation of the data around the time of failure indicates that either the power regulator or the data handling circuitry has failed.

2.0 Introduction

The Apollo 15 Lunar Surface Magnetometer (LSM) had previously experienced anomalies in the Y axis sensor, which resulted in both the loss of data and the loss of the gimbal flip capability. The present anomaly resulted in the loss of all data.

The flip-calibrate command has been transmitted to the experiment on a regular basis since the anomaly and has, on occasion, resulted in apparent attempts by the experiment to perform the calibration sequence. The data has been erroneous or off-scale on all occasions.

3.0 Analysis

Three facets of the anomaly were investigated.

- (a) The actual time of failure
- (b) Evaluation of failure
- (c) Impact on the remainder of the ALSEP system and experiments.

The analysis was performed by replaying duplicated data tapes from Houston. Extreme difficulty was experienced in analyzing the tapes using the System Test Set because of noise and jitter on the signal which prevented the data processor from achieving lock. This problem has been discussed more fully in ASTIR/TM41-2.

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3.1 Time of Failure

The failure was determined to have occurred at 15.07.33 hours GMT., on December 10, 1973. This was the time at which all data indicated the binary "1" state.

3.2 Evaluation of Failure

The experiment data prior to the failure was examined to determine if a degradation or abrupt change occurred.

Immediately prior to the failure the engineering data indicated that the electronics base and internal temperatures were at 90°C and 108°C respectively and that the supply voltage was 5.9 volts. Values for these parameters at the same sun angle on the previous lunation, were 62°C, 73.3°C and 5.1 volts respectively. The heater status indicated that the heater was on, when it should have been off at this sun angle (approx. 90°).

To evaluate this phenomena, the temperature trend was examined over the previous twenty four hours and compared with the changes in the heater status, supply voltage and reserve power.

We determined that there was no temperature trend, but that a step change occurred. The status changes were found to have occurred as follows,

- (i) At approx. 01.40.00 on day 344 (10 Dec. 1973)
  - (a) The heater status changed from OFF to ON.
  - (b) The range status changed from  $\pm 100$  to  $\pm 200$
  - (c) The Y axis field offset changed.
- (ii) At approx. 03.57.00 on day 344 the supply voltage changed from 5.1 volts to 5.9 volts.
- (iii) At approx. 04.12.00 on day 344 the temperatures on the base and electronics increased by approx. 30°C.

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- (iv) Two other status changes occurred at an unknown later time:
- (a) The Z axis gimbal position status changed from the post to pre site survey position
  - (b) The Y axis control/off to the X axis control for the heater
  - (c) Two status bits in word 5, step 16, changed. These bits are not used.

The above status changes fluctuated between the two conditions several times before becoming permanent. The changes are represented by 1 bit in the output and it was the same bit which changed in every case (either most significant bit or least significant 2 bits).

Analysis shows that the status changes did not occur, but were merely status bit changes. This was proven as follows,

- (a) The reserve power never changed by more than one bit, which indicates that the heater did not turn on.
- (b) The range did not change because the data output counts remained at the same levels.
- (c) The temperature change was too abrupt to be real.
- (d) Unused status bits changed.

It is concluded that the experiment electronics degraded over a period of several hours, resulting in complete loss of data. The cause of the failure cannot be isolated to any particular circuit.

### 3.3 Impact on the Remainder of ALSEP

This fault will not affect ALSEP or the other experiments except in consideration of experiment turn off as RTG power reduces. After the Solar Wind Experiment has been turned off, the next decision point is at 66 watts. All other things being equal the LSM should probably be turned off at that point as it is giving no useful data. Until that time there is nothing to be lost by leaving LSM on to see if it recovers.

4.0 Conclusions and Recommendations

We conclude that the experiment degraded over a period of several hours around lunar noon. The degradation was exhibited as random bit changes in engineering and status readouts.

The failure will not affect the ALSEP Central Station or the other experiments.

We recommend that the experiment be left on until the RTG power falls to 66 watts, and the data monitored for any indications of experiment recovery.