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EARTH RADIATION BUDGET SATELLITE (ERBS) ORBITING PROFILES AND Ni-Cd USE

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Summary

The Earth Radiation Budget Satellite (ERBS) is one of the more recently launched satellites of the Goddard Space Flight Center. This paper presents the flight data of the two 50 Ah NASA standard batteries that are being flown on the ERBS. Trend characteristics of the batteries were collected over a period of two years. The parameters that were trended are; the battery end-of-discharge voltage, time in peak power track, and time in constant current mode. All were plotted versus mission elapsed time. The slopes exhibited by the trended parameters indicate no adverse trends that would signify any appreciable degradation in the batteries.

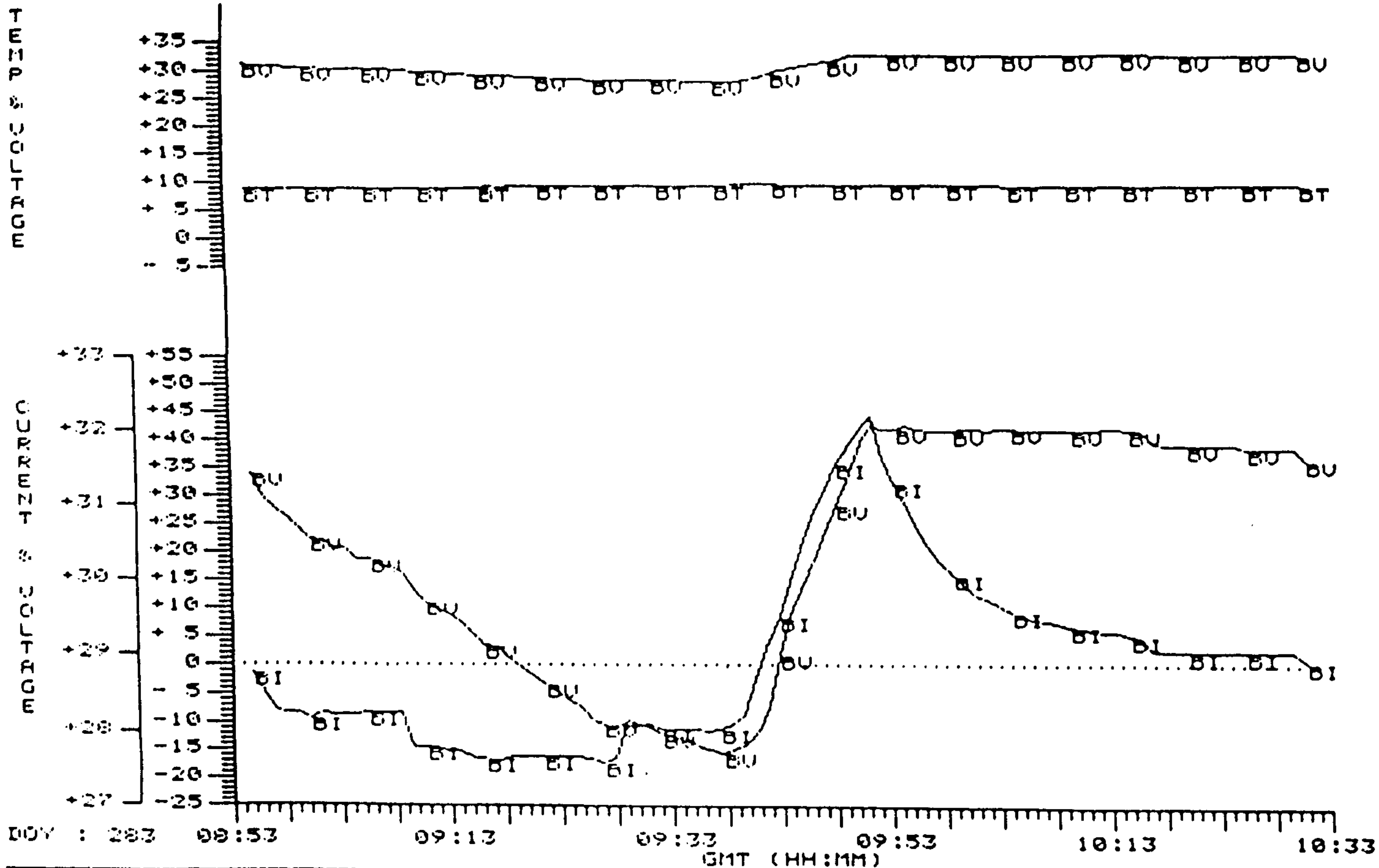
Introduction

The succeeding paragraphs provide a brief background of the ERBS orbital regime and power system configuration in the normal operating mode.

The ERBS was launched on Oct. 5, 1984 from the Space Shuttle Challenger to a 600 km circular orbit with an inclination of 57 degrees from the equator. This orbital configuration gives ERBS a 97-minute orbital period and ocassional periods of full-sunlit orbits.

The ERBS power system has a peak power tracker, a constant current trickle charge mode (C/50), and an on-line ampere-hour integrator. These components together with the VT limiting capability controls the charging of the two batteries connected in parallel. The batteries share a common load. Charge control is dependent on the hotter battery, which is battery number 1. These batteries are charged to 32.12 volts (1.46 v/cell), equivalent to the Goddard VT6 at an average temperature of 9 degrees C. The average depth of discharge the batteries are subjected to is 10%.

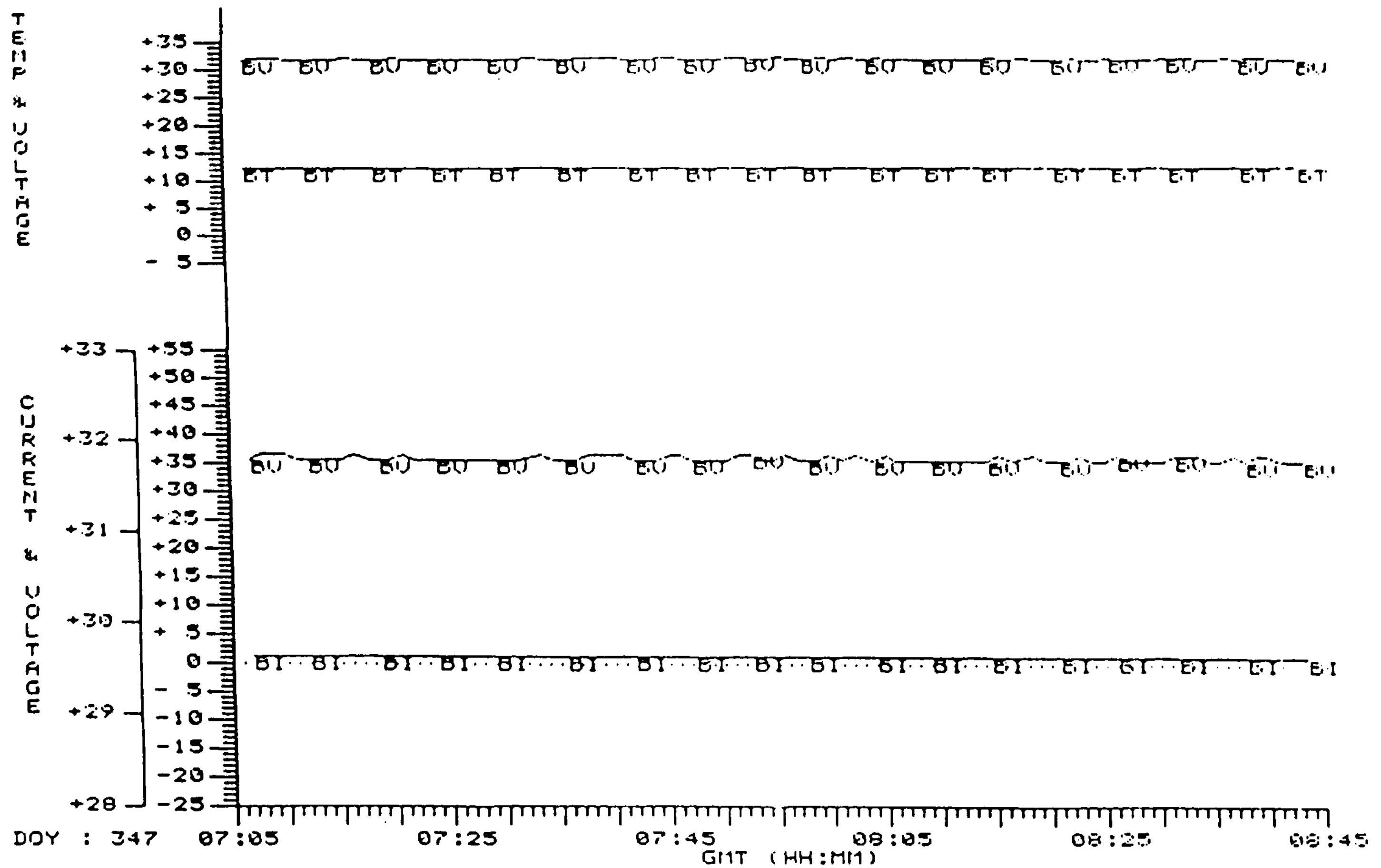
Shown in Figure 1 is a typical single orbit power profile of the ERBS. As shown, as soon as the solar arrays see sunlight the peak power track takes over and charges the batteries until the voltage reaches the selected VT setting. From here the voltage limiting mode of charging takes place as indicated by the taper charge until the ampere hour integrator indicates 100 % SOC. The batteries are then charged at the constant current mode equivalent to a C/50 charge rate. Figure 2 shows the orbital power profile



ORBIT NO. 10949 BATT △ T > 2 C NO MINS IN KI CTRL 13.9 BATT AMP HR OUT 9.22
BETA ANGLE 56 BATT THERM DISP 40.1 VT LEVEL 6 C/D KI/TOT 1.095/1.156
AHM LOW SOC NO AHM MIN SOC 90.35 C/D LEVEL LVL2 BATT MAX VOLTS 32.082
BATT △ V > 1 V NO MINS IN VT CTRL 24.5 BATT AMP HR IN 10.66 BATT MIN VOLTS 27.712

BV = Battery Voltage BT = Battery Temperature BI = Battery Current

Figure 1. ERBS Orbital Power Profile.



ORBIT NO. 1018 BATT Δ T > 2 C NO MINS IN KI CTRL 0.0 BATT AMP HR OUT 0.00
BETA ANGLE 11 BATT THERM DISP ≈ 45.8 VT LEVEL 6 C/D KI/TOT [illegible]0.000
AHM LOW SOC NO AHM MIN SOC 100.00 C/D LEVEL LVL2 BATT MAX VOLTS 31.845
BATT Δ V > 1 V NO MINS IN VT CTRL 0.0 BATT AMP HR IN 0.00 BATT MIN VOLTS 31.79[illegible]

BV = Battery Voltage BT = Battery Temperature BI = Battery Current

Figure 2. ERBS Orbital Power Profile.

when the spacecraft is in full-sun. Notice that the batteries remain at a constant current charge and the temperature is about 4 - 5 degrees over the orbital average of 9 degrees C.

Flight Data Presentation

For the purpose of providing consistency in the data used in trending the selected battery parameters, a similar orbit comparison technique was used. Data from sun angles 45 and 90 degrees were selected due to their outright availability and for no other reasons. Although, data from the 90 degree sun angle region, which happens to be the worst case eclipse period, gives a more representative end-of-discharge voltage. All the data used for the trending were taken from the orbital power profiles ran for the selected sun angles.

Figures 3 and 4 show the Time in Peak Power Tracking and Time in Constant Current Charge respectively. Both parameters were plotted versus mission elapsed time. Pertinent spacecraft configuration and load conditions for all the data used in both figures as well as Figure 5 are as follows:

Sun angle : 45 +/- 5 degrees
Minimum State of Charge : 93 +/-0.5%
Loads : No power amplifier usage
Current at End-of-Discharge : 12 +/- 2 amps.

Sun angle : 90 +/- 2.5 degrees
Minimum State of Charge : 91 +/-1%

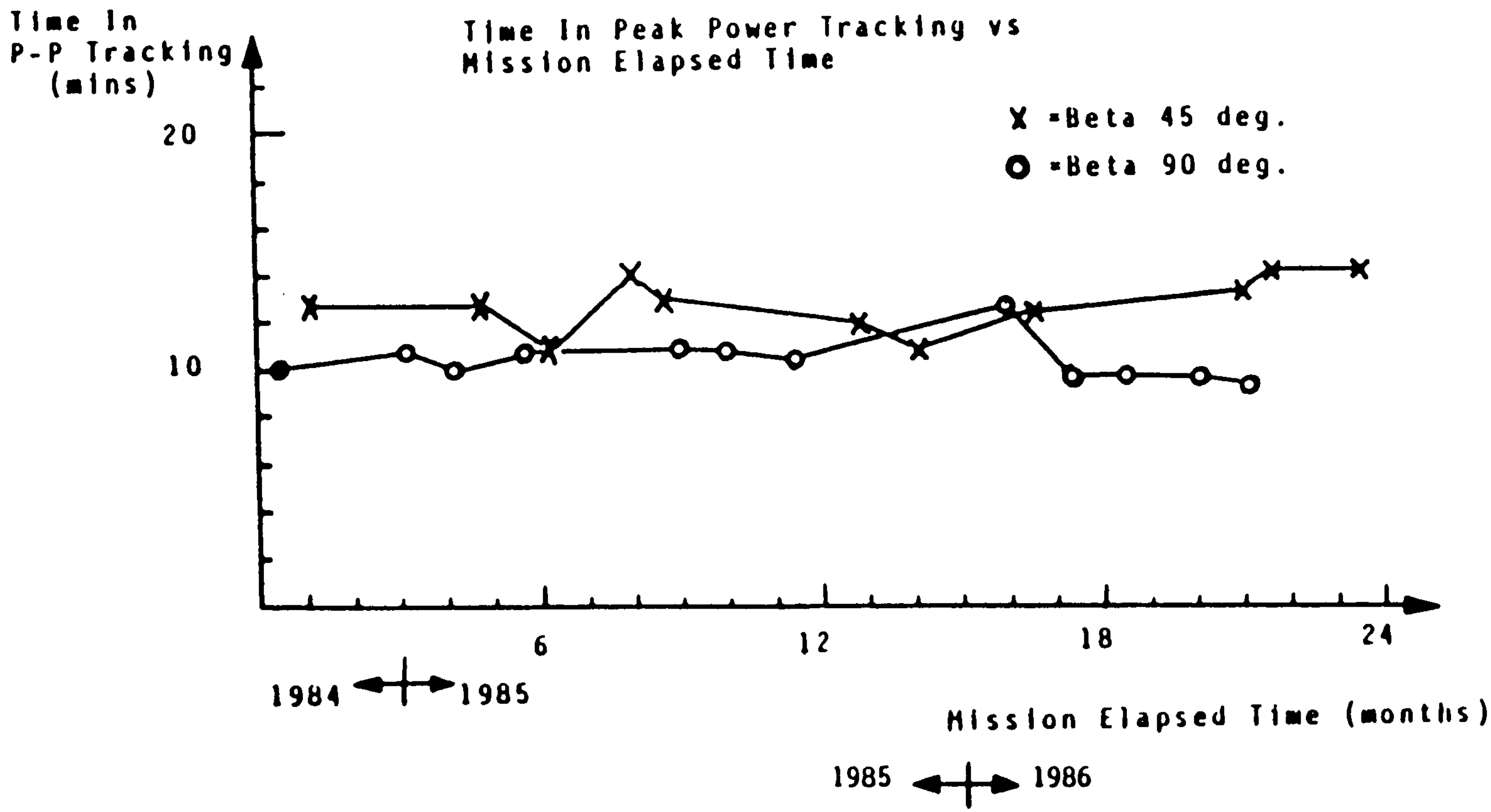


Figure 3. Time Spent Peak–Power Tracking.

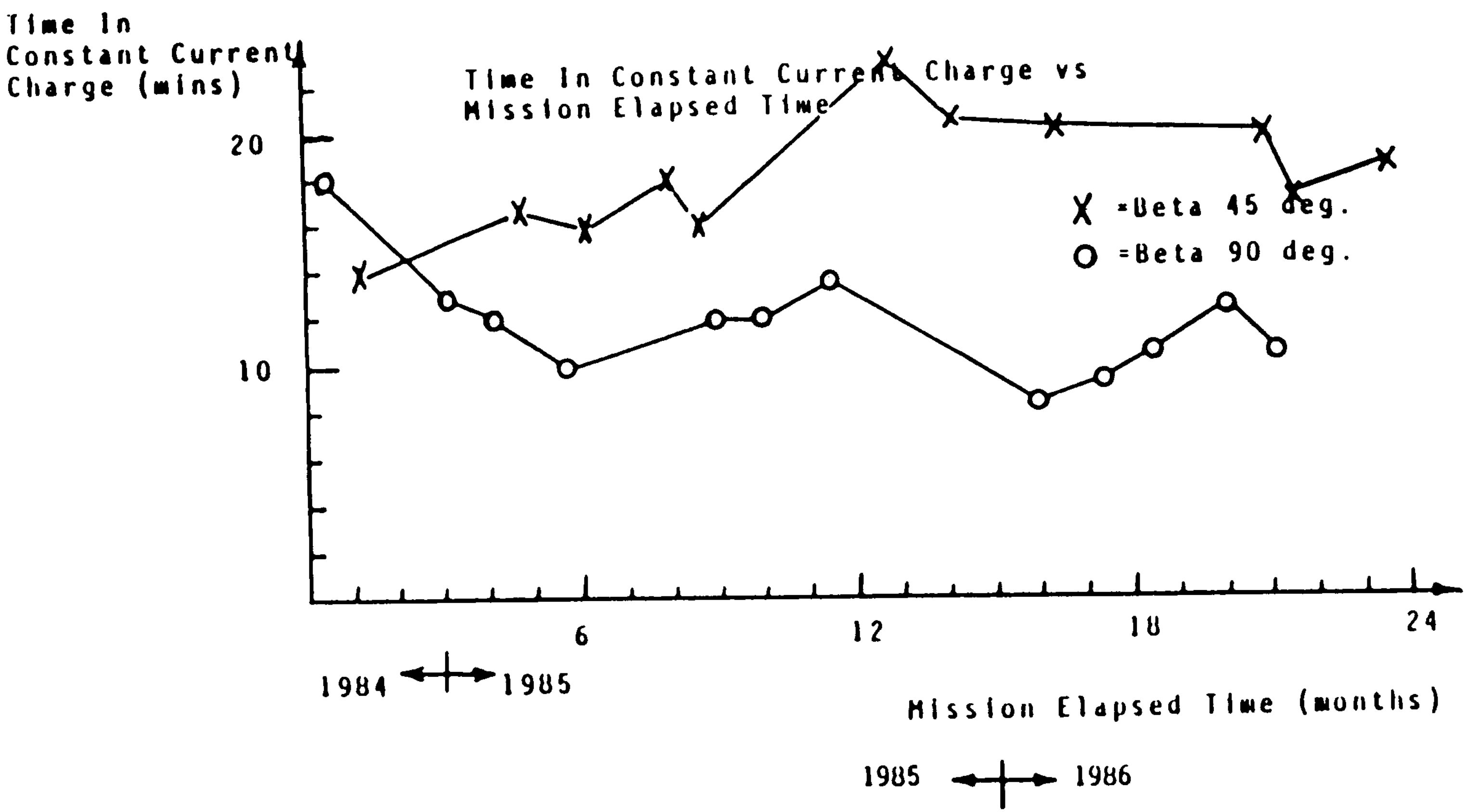


Figure 4. Time Spent in Constant Current Mode.

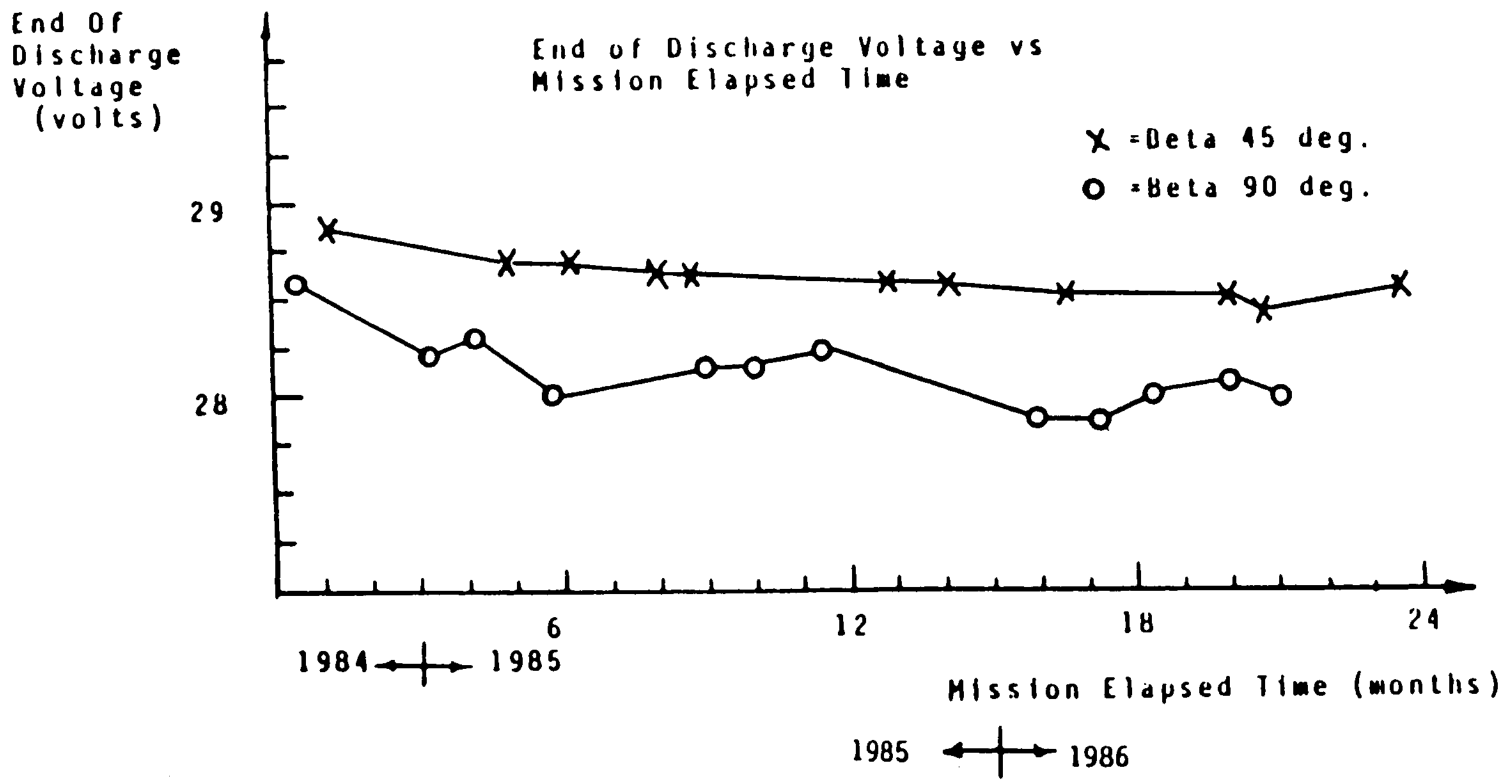


Figure 5. End of Discharge Voltage.

Loads : No power amplifier usage

Current at End-of-Discharge : 10 +/-1.5 amps.

Of the three parameters trended only the End of Discharge Voltage versus mission elapsed time (Figure 5) shows any discernable trend. The plot shows a slight decrease in the end of discharge voltage over the two-year period.

References

1. P. C. Lyman, ERBS Power Subsystem Trend Data, Ball Aerospace Systems Division, SER ERBS 05-57, Rev. B, 09-19-86