A Loose Screw on HST: Its Effect on HST Observing Programs

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ABSTRACT

A hardware problem in the HST power system has caused overcharging of 2 of the 6 on-board batteries, which, if nothing was done, could result in battery overheating and possible failure. This, in combination with a general increase in power consumption by the newer on-board instruments, has led to a need to revise some spacecraft constraints in order to maintain adequate power to HST.

This report describes the actions taken by the NASA Goddard HST Project to address this need and their effect on the scheduling of HST observing programs

1. The Problem

In the spring of 1998 an anomaly showed up in the HST power system, indicating that a 20 milliohm resistance had developed in one of the power busses that combines power from batteries 5 and 6. An engineering analysis tentatively identified the fault as a loose screw connecting two copper bus bars. The net result of this fault is an imbalance in distribution of the load carried by all 6 batteries: batteries 5 and 6 carry less of the load during night time than the other batteries and therefore are discharged less rapidly.

This load imbalance causes two problems:

- Since batteries 5 and 6 carry less load than planned, there is less power available to the system. This shortfall is magnified by a general increase in power consumption by the newer instruments installed in past servicing missions.
- The charging of batteries by the solar arrays is *not* affected by the fault (i.e., all the batteries are charged at the same rate). The nominal charging capacity is now too much for batteries 5 and 6, resulting in overcharging the batteries -- something not good for their long term health -- and can lead to thermal runaway situations. If these runaways are not caught and corrected by ground action, they could lead to a dramatic increase in the internal battery pressure. Power system engineers have been monitoring the situation closely and have intervened in real time on several occasions to disconnect solar array segments from batteries 5 and 6.

2. The Solution

One of the solar array segments has been removed from the circuit charging batteries 5 and 6. This reduces overcharging and avoids runaway situations, but the removal of a solar array segment reduces the overall power available to HST during daylight hours (only 17 of 20 array segments are now being used). In order for HST to remain power positive, the maximum sustained sun to solar array normal angle (sun incidence angle) has been reduced from 25 to 20 degrees. Also, in the past the arrays have been allowed to go up to a 35 degree sun incidence angle for brief periods of time (up to 4 orbits). Now this angle will be restricted to no more than 25 degrees for a single orbit.

The consequence of these new restrictions is to reduce the roll angle flexibility, the angle around the HST V1 axis or bore sight, used in scheduling the telescope. The magnitude of this effect is a function of the angle between the HST's V1 axis and the sun (the affected range is between 90 and 135 degrees) and can reduce the allowed roll flexibility by as much as 8.1 degrees (illustrated in the following table).

Table 1. Old and new values of the maximum allowed off nominal roll

V1/Sun angle (degrees)	Old maximum off nominal roll allowed	New maximum off nominal roll allowed
93	24.21	16.74
108	25.46	17.35
132	22.14	21.76

3. Effect of the Changes on HST Observing Programs

This reduced flexibility in HST scheduling can affect programs having either restrictions in orientation or time (e.g., visits using special requirements such as ORIENT, ORIENT FROM, AFTER, BEFORE and BETWEEN).

- The plan windows for a majority of programs (and visits) are unaffected.
- Out of 348 programs having external targets, 158 are affected. The plan windows of 421 visits (out of 1503 visits) shifted to different times and became narrower.
- 44 visits became came unschedulable because the requested orientation is outside the new limits -- usually visits having both orientation and timing restrictions, such as a combination of ORIENT FROM with large angle separations and tight AFTER BY timing links between visits.

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