

ST5 Clarifications/Corrections to Multiple Spacecraft Missions Lessons Learned
for the NASA Heliospherics Division Final Report

- Section 4.1 and Finding #CD-1: The ST5 spacecraft were *nearly* identical. Two of the spacecraft had the evolved antennas on the top deck, and the quadrifilar helix antenna on the bottom deck, whereas the “middle” spacecraft was the opposite. This was because of the way they were placed in the Pegasus Support Structure (launch dispenser). The first spacecraft had no Variable Emittance Control (VEC) technology, the second spacecraft had an Electro-Static Radiator VEC (only) and the third spacecraft had Micro-Electro Mechanical Systems (MEMS) and ESR VECs.
- Section 4.1 and Finding #CD-2, The level-1 requirement for constellation operations did not have an explicit fall-back to two spacecraft. The minimal mission *requirement* was for one spacecraft (with no constellation operations). If there were two spacecraft, we would have been able to learn things about constellation operations, but that would not have met the constellation requirement.
- Finding #CD-3, Our analysis of the ST5 mission costs indicates that the second two spacecraft cost approximately \$8M each. The “cost 84% of the budget” for the first spacecraft cited in the report is misleading. It is probably based on
 - first spacecraft cost = \$130M total mission cost - \$30M launch vehicle cost - \$8M second spacecraft - \$8M third spacecraft

However, that assumes that the total cost of the ground system, mission operations and science operations would be attributable to the first spacecraft. Excluding those items, the first spacecraft cost is approximately 70% of the total mission cost excluding the launch vehicle. From a lessons learned perspective, the first spacecraft cost is still inflated compared to the others, because it includes most of the cost growth due to the lengthy launch vehicle and mission profile uncertainty (i.e. change from secondary payload launch into Geo-Transfer Orbit to Pegasus launch into Low Earth Orbit and corresponding nearly 2 year delay in launch date).

- Finding #CD-23, ST5 did not have a safe/hold configuration per se. The spacecraft had an on-board startup sequence, which included the schedule and commands for communications with the ground stations. Thus, the spacecraft started up and started executing their on-board schedules, including transmitting on schedule to McMurdo and/or Deep Space Network ground stations (as appropriate based on their id's).
- Finding #M-2, The ST5 I&T team did not conduct Mission Operations. However, the Mission Operations staff did participate in I&T (thermal vacuum and operations simulations), and systems and subsystem personnel participated in both I&T and Mission Operations.