Thermal Qualification of the LunarSat Microorbiter

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This paper provides an overview of the design and analysis of the LunarSat thermal control system (TCS).

A preliminary thermal model (45 nodes) for the orbiter has been created in 1998. It basically represented the structure and the tanks including an overall power dissipation. It also defined the thermal coatings for the inner and outer surfaces including the definition of Multi Layer Insulation (MLI) and Radiator areas. The analyses were focussing on the lunar orbit, taking into account a detailed thermal model of the Moon fluxes.

The second model is a separate detailed thermal model of the propulsion system, along with a reduced model of the spacecraft (556 nodes). For this model two worst cases have been analysed - the Worst Hot Case (WHC) and the Worst Cold Case (WCC). The WHC is reached during the 900s burn of the four main thrusters to leave GTO. Due to the high temperatures in the nozzles there is a large heat flux to the piping system and the resulting heat radiation induces large thermal stresses in other parts of the satellite. Therefore, additional radiators have to be considered or some insulation has to be added. The WCC is reached during the 4-hour eclipse in lunar orbit. While the orbiter has no heating radiation from the Sun, temperature has to be regulated by internal heaters and supported by the thermal capacity of the structure. The layout of these heaters also has a major impact on the power system.

A third model representing the spacecraft in more details, in particular the Upper Bay has been built-up. This model is currently being finalized.

All these thermal models have been created using the thermal software tools ESARAD, THERMICA_ and ESATAN_.

Many changes have been made by the Lunarsat team concerning material selection, structural design, and power budgets. The aim is to create a detailed model of the microorbiter to calculate the temperatures of all components in GTO, trans-lunar orbit and in orbit around the Moon to ensure safe temperature levels. This is critical because some of the most temperature-sensitive components are vital to mission success. The thermal model is required for verification of the existing design and for determination of the position of heaters and additional heat shielding.

Now a detailed model of the spacecraft has to be finalized including reduced models of all major S/C and P/L components. Thermal interfaces have to be defined between the S/C thermal model and the detailed thermal models (i.e. for the propulsion system, High

Resolution Camera, LPP Box, etc.). A detailed power budget will result in the complete calculation of the fluxes for GTO, LTO and different lunar orbits.