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THERMAL DESIGN OF A RADIATOR FOR A MARS LANDER ATMOSPHERIC SENSOR

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ABSTRACT

A SINDA/G thermal model of the MVACS MET-TDL (Mars Volatiles and Climate Surveyor Meteorological Station Tunable Diode Laser) at the MSP-98 (Mars Surveyor Program -- 1998) landing site (areocentric longitude Ls = 270° and latitude Lat = -75°) has been developed. The lander was assumed to be oriented without tilt and such that the vertical radiator surfaces face northwest (toward the sun). The dependence of the MVACS MET-TDL laser diode temperature on radiator size and radiator and housing surface optical properties has been determined. The radiator areas considered were ½" x 'A", 1" x 1", and 2" x 2"; the emissivities assumed were 0.05, 0.10, and 0.15. Diode/TEC power dissipation was fixed at 0,6 W, continuous. The sky sink was 140 K. The optical depth was assumed to be 1.0.

The diode temperature depends strongly on radiator size (and by inference, on laser/TEC power dissipation levels); the diode runs coolest when the radiator size is largest. For the conditions considered, for a 2"x2" ("large") radiator, the diode laser temperature ranges each day between 207 K and 227 K. For a ½" x ½" ("small") radiator, the diode laser temperature ranges from about 285 K to 297 K.

Temperature sensitivity of the MET-TDL diode laser to the surface emissivity value of its radiator has been established. To achieve maximum laser stabilization temperature of around 290 K, a 1" x I" radiator requires a surface emissivity of around 0.30. Some candidate surface coatings and/or treatments that provide the desired emissivity are listed.

The diode temperature is not a strong function of the MET-TDL housing emissivity.

But if, on the other hand, the housing itself is employed as the radiator, then the diode temperature is a strong function of housing emissivity. To keep the diode as cool as possible, the housing should be coated with a high emissivity material.

The laser diode temperature levels and ranges do not depend on the areocentric longitude (i.e., on "warm" versus "cold" environment).

References:

"Solar Radiation on Mars", J. Applebaum and Dennis Flood in Solar Energy, Vol. 45, No. 6, pp. 353-363, 1990.

"Satellite Thermal control Handbook", David G. Gilmore, Ed., The Aerospace Corporation, 1994.