Operational Thermal Control of Cassini Titan Flybys

Abstract

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The Cassini spacecraft will fly by Saturn's largest moon, Titan, forty-five times during its science tour. Titan's atmosphere is planet-like and is denser than Earth's atmosphere. Twenty-five of the flybys will have a relatively low closest approach target altitude in Titan's atmosphere and are of thermal concern. The Thermal/Devices Team on the Cassini Project in Mission Operations at the Jet Propulsion Laboratory has designed an operational thermal control strategy for these flybys. The challenge was to provide flyby operational thermal control that enabled science and remained within design limitations and Project constraints.

While all environmental heat loads were taken into account, the dominant heat load was the aerodynamic heating at the lower target altitudes. Its magnitude can be comparable to absorbed direct solar loads in the inner solar system. This was a concern for science instruments that must avoid even relatively small direct solar heat loads at Saturn. Thermally induced power transients were also a concern.

Planned flyby scenarios were evaluated where the spacecraft performs science activities requiring certain attitude and power profiles. Fault induced "Safing" response scenarios were also evaluated. A Safing response can happen at any time. An onboard Safing response to a fault will reconfigure the power and attitude profiles for spacecraft protection and for communication with Earth.

This evaluation is based on the Project accepted Yelle model of the Titan atmosphere, currently planned flyby trajectories, and science gathering and Safing attitude scenarios and power profiles. Thermal engineers adopted a Systems' approach that insured appropriate risk mitigation and information accuracy.

The paper focuses on the technical thermal control evaluation and resulting solutions, the Systems' level approach taken, and lessons learned in an operations environment.

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