Radioisotope Thermoelectric Generator Waste Heat System for the Cassini Propulsion Module

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ABSTRACT

This paper dc.scribes the Radioisotope Thermoelectric Generator (RTG) waste heat system; its development, performance, and effectiveness at controlling the temperatures for the propulsion module for the. Cassini Space.craft.

To explore the Saturn system the Cassini spacecraft relic.s on [he. electrical power from these. RTGs, but the. large power demand for science and engine.cring functions severely limits the. electrical power available for temperature control purposes. The waste heat system transfers heat radiative.ly and conductively from each RTG to the. propulsion module to maintain temperatures and establish a stable, temperature sink to which the rest of the. orbit r is thermally anchored.

INTRODUCTION

CASSINI MISSION OVERVIEW. Cassini will be launched on a Titan IV/Centaur in the October 1997 launch window (1). The first burn of the Centaur upper stage places Cassini into a low-Earth orbit and the second burn injects the spacecraft (S/C) on the first leg of a trajectory (Figure 1) that depends on gravity assist flybys of Venus (twice.), 1 Earth and Jupiter to intercept Saturn in 2004. The last gravity assists at Jupiter increases the S/C velocity (relative to the sun) from 11.6 KM/sec to 13.6 KM/sec (25,948 MPH to 30,42.2 MPH). After almost a seven year flight, one of the two 400N liquid rocket engines, firing for 88 minutes, inserts the S/C into orbit about Saturn. The orbiter will be active for Up to four years exploring Saturn, its rings and its numerous moons. More than thirty flybys of the moon Titan are planned and on onc of [he. early encounters a probe will be launched into the Titan atmosphere.

An international team consisting of approximately 1300 people in 16 European countries and 3000 people in 32 states in the US arc designing, fabricating, and planning to fly the Cassini S/C (1). The 'Titan probe, named Huygens after the. Dutch scientist who discovered Titan and the. Saturn rings, is being developed by the European Space Agency. Both the. mission and the S/C bears the name of the French-Italian astronomer, Jean Dominique Cassini, who discovered several of the moons of Saturn and the. gap in Saturn's main rings. The High Gain Antenna is provided by the Italian Space Agency. 'There arc European experiments on the orbiter and US experiments on the probe. The orbiter is being assembled by the Jet Propulsion Laboratory which will also manage the Cassini mission for the National Aeronautics and Space Administration.

The trajectory results in a solar environment which exposes the S/C to 2.7 suns (perihelion, .61 AU) and 0.01 suns (Saturn, 10 AU). And, the pass through the. shadow of Saturn can last up to 18 hours. Although the S/C is 3 axis stabilized and sun oriented, there. arc many off-sun maneuvers for trajectory corrections/communication purposes. These mane.uvers arc. time constrained until the. S/C is beyond S AU. Inside of S AU all of the maneuvers are performed such that full advantage. is taken of the shading provided by the 2.7-meter-diameter probe. While sun oriented, the 4-mete.r-diamc.ter High Gain Antenna shades the S/C.

CASSINI SPACECRAFT CONFIGURATION - Two views of the mechanical configuration, without thermal blankets, arc shown in Figure 2. In addition to the science complement on the Huygens probe, there are twelve science subsystems that remain with the orbiter. Mounted on the Remote Sensing Pallet arc the primary and backup Stellar Reference Units (star trackers), the. Visual and Infrared Mapping Spectrometer, the wide and narrow angle cameras of the Imaging Science Subsystem, and the Composite Infrared Spectrometer. Two magnetometers arc mounted on the. Magnetometer Boom Assembly which, for thermal protection, is deployed after the second Venus flyby and after reaching 0.85 AU. The Ion and Neutral Mass Spectrometer, Plasma Spectrometer, and part of the Magnetospheric imaging Instrument mount off of [he. Fields