IAF SPACE OPERATIONS SYMPOSIUM (B6)
New Space Operations Concepts and Advanced Systems (2)

Author: Mrs. Anuradha Prakasha
Indian Space Research Organization (ISRO), India

Mrs. Pramoda Hegde
Indian Space Research Organization (ISRO), India
Mrs. T.K. Anuradha
ISRO Satellite Centre (ISAC), India

ELECTRIC PROPULSION IN A TWO TON COMMUNICATIONS SPACECRAFT - OPERATIONAL CHALLENGES

Abstract

Electric Propulsion (EP) is an attractive option for spacecrafts owing to its high specific impulse when compared to conventionally used chemical propulsion. ISRO launched and operationalized its first spacecraft with EP in May 2017. The spacecraft was GSAT-9, with a mission goal to provide communication services in Ku-band with coverage over South Asian countries. GSAT-9 is configured around ISRO's standard I-2k bus, with a lift-off mass of 2230 kg and targetted mission life of 12 years. The power generation is 3.5 kW. The EP was to be included in the I-2K bus, in addition to Chemical Propulsion, within the given mass and power budgets. The objective was a technology demonstration to assist in Station Keeping. The EP system comprised four Stationary Plasma Thrusters (SPT) with 18mN thrust, demanding an additional power of 570W from the already power-optimised spacecraft bus. The challenges of configuring and operating EP were multifold - thermal management of high dissipating EP elements, power management through a newly designed EPS bus(Electric Propulsion System bus), inclusion of onboard sequencer for Electric Pressure Regulator mode of SPT operations and so on. The EP system demanded a thorough conditioning and initialization before being operationalized. Ground operations were planned meticulously to address all challenges. A mission strategy was worked out to plan the SPT operations calender wrt the deltaV requirement, energy balance (including eclipse/shadow analysis), plume impingement and SADA offset. All operations, for both Electric and Mechanical Pressure Regulators, were streamlined and laid down as well documented procedures. Ground events,based on Telemetry, were defined to detect any contingency and send required commands. Momentum dumping and attitude management in the absence of thruster pointing mechanism was another challenge. For on-orbit phase of operations, a judicious mix of onboard and ground automation was built in to cater the station keeping requirements, including error correction. Additionally, a mimic for EP system was developed to provide a quick-look assessment of the EP functioning. Ground operations were planned such that it was possible to demonstrate the EP system in the drift orbit itself, imparting the deltaV required for trim maneuvers as part of orbit raising. EP system in GSAT-9 is working satisfactorily, as per plan, with approximately 4 hours of firing each day at the nodes and contributing to the mission life. The objective is met and has paved the way for upscaled implementation of this system for a low mass, cost-effective solution.