TARGET MARTIAN ORBIT SELECTION FOR ISRO MARS ORBITER MISSION

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Abstract

Mars Orbiter Mission (MOM) is Indian Space Research Organisation's (ISRO) first interplanetary endeavor with an orbiter craft designed to orbit Mars in a safe elliptical orbit. MOM was a challenging technological mission as well as a science mission, considering the critical mission operations and stringent requirements on propulsion, communications and other bus systems of the spacecraft. One of the main objectives of the mission was to develop the technologies required for design, planning, management and operations of an interplanetary mission. The MOM s/c, with a lift-off mass of about 1350 kg with propellant loading of 852 kg, was planned to be launched by PSLV in Oct/Nov 2013 into an elliptic parking orbit of size 250 x 23000 km with inclination 18 deg. The flight dynamics team at ISAC was assigned the task of specifying the target Martian orbit for MOM considering the spacecraft platform as well as payload constraints. During the feasibility studies carried out earlier, the Mars arrival periapsis altitude was chosen as 500 km considering Navigation and other operational uncertainties. The apoapsis altitude was chosen as 80000 km to limit Mars Orbit Insertion (MOI) delta-V and enable achieving the Mission with PSLV launcher's capability. The committed operational life of the s/c in Martian orbit was six months. The other orbit parameters of Inclination, Right Ascension of Ascending Node and Argument of Perigee were selected after a detailed analysis to meet the following Mission constraints:- maximum eclipse period should be less than 100 min; imaging of Mars full disc from apoapsis region should be possible from Day 1 after MOI; orbit periapsis altitude should be stable at least for one year considering all the perturbative forces. The achievable range of Martian orbit inclination values were found to be from 29 deg to 151 deg in Mars IAU frame of reference, since the declination of the V-infinity of the Mars arrival hyperbola was -29 deg. Seven orbits, two direct, one polar and four retrograde orbits were targeted in the maneuver design and studied with respect to the delta-V cost of achieving the orbit, the sun-orbit geometry after MOI, the eclipse characteristics, orbit stability and imaging opportunities. The star sensor mounting configuration requirement and occult management was also studied for each of the orbits. The retrograde orbit of size 500 x 80000 km, with 151 deg inclination, ascending node of 61 deg and argument of perigee of 206 deg, was found to be the most suitable orbit satisfying all the specified constraints as well as from the viewpoint of star sensor mounting and management of star sensor occults. MOM was successfully launched on 2013 Nov 5, from Satish Dhawan Space Center, Siharikota, India into the expected EPO and all orbit/trajectory maneuvers were successfully carried out and the spacecraft was captured into the desired target Martian orbit on 2014 Sep 24 around 02:00 UT as per plan. A full disc image of

Mars was taken by MOM’s Mars Color Camera (MCC) from the apoapsis region after MOI and all further imaging opportunities, observed eclipse pattern and orbit evolution were all as per predictions.