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Orbit Determination and Propagation (9)

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IRNSS-1H/PSLV-C39 ORBIT EVOLUTION AND RE-ENTRY ANALYSIS

Abstract

IRNSS-1H was launched on-board PSLV-C39 on 31st August, 2017 from Shriharikota (India). Due to failure of payload fairing separation, spacecraft could not attain its intended sub-GTO orbit. Orbit determination was carried out using 2 hrs and 36 min of available tracking data. A very low orbit was achieved with 164 km perigee height and 6585 km apogee height with 19.2 deg inclination. The orbit period was 2 hr 39 min. Liquid engine firings using on-board LAM engine, were attempted to help s/c come out of the payload fairing and passivation of propellant. IRNSS-1H trapped inside the payload fairing along with the dry PS4 stage is considered as object for study.

Detailed orbit evolution and decay analyses were carried out since September 2017 till 2nd March 2019. In this paper, different case studies have been presented and results are discussed. Orbital decay prediction strongly depends on the cross-section area normal to velocity vector, mass of the object and space weather in the low-Earth environment. In the absence of attitude information of the object, the exact cross section area for drag was not available. For the prediction of earliest date of decay, analysis was carried out with maximum area to mass ratio. The dry mass of PS4 and satellite was 873 kg and 597 kg respectively. The payload fairing mass was 1182 kg. Two cases were considered for total mass of object: 2675 kg which also accounts for the residual propellant and 3480 kg which includes 828 kg of propellant. The maximum and average cross section area considered is 23.42 m² and 16 m² respectively. Latest available solar flux and geomagnetic index data have been considered in the analysis. The re-entry start is assumed when perigee height is near 120 km.

The final re-entry prediction provided in this paper was very close to JSpOC results posted on www.space-track.org. JSpOC final re-entry prediction was at 19:23 UTC on 2nd March 2019 at -19.1 latitude and 174.3 longitude. In comparison, our prediction was at 19:27 UTC on 2nd March 2019 at -19.0 latitude and 168.2 longitude. The same orbit was monitored to check the latitude and longitude predicted by JSpOC, and it was observed that the same condition was achieved at 19:28:30 UT when perigee height was 119.4 km. Based on this accurate prediction, it was interpreted that during the attempt of Apogee motor firing and venting, most of the on-board propellant remained intact.