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Author: Dr. Rafail Murtazin
Rocket Space Corporation Energia, Russian Federation

"QUASI-COPLANAR INSERTION" TO IMPLEMENT QUICK TWO-ORBIT RENDEZVOUS PROFILE OF SOYUZ SPACECRAFT

Abstract

The paper describes the reduction of the vehicle autonomous flight duration before docking to the ISS. Due to the limited volume inside Soyuz the reduction of time till docking to the ISS is very important, since the long stay of the cosmonauts in the limited volume adds to the strain of the space flight. In the previous papers of the author it was shown that the existing capabilities of Soyuz, the ISS and the ground control loop make it possible to transfer to the four-orbit rendezvous profile. Since 2012 Russian spacecrafts as Soyuz and Progress began to use this new short rendezvous profile. To date more than 20 spacecrafts have successfully performed quick docking. Despite the success achieved more fast flight from insertion to docking with ISS remains relevant due to cosmonauts' schedule on the launch day which shows that its duration is at the limit of allowable. Over the past years Russian specialists got considerable experience in the preparation of ballistics conditions for quick rendezvous despite a busy schedule of flight operations on the ISS. These ballistics conditions are determined by the allowable angular distance (phase angle) between chaser and target at the chaser's launch time. Also now Soyuz and Progress have autonomous satellite navigation and for their insertion used more accurate launch vehicle. Together, this allows a faster profile. The paper describes new approach which called as "quasi-coplanar insertion", when orbit plane of chaser a little bit differ from orbit plane of target, but with permissible phase angle. This approach is not requires additional changes in spacecraft software and allows to decrease flight duration till docking to 2 orbit or about 3 hour. Before using this profile for Soyuz flight offered to perform several demonstration flights on the Progress for confirmation the correctness of the embedded principles. The paper considers the possible improvements of the proposed approach and recovery from the contingencies.