SPACE OPERATIONS SYMPOSIUM (B6)
Human Spaceflight Operations (1)

Author: Dr. Evgeny Menkin
ARES Aerospace, United States

Mr. Robert Juillerat
Booz Allen Hamilton, United States

TRANSITIONING ISS DYNAMIC EVENTS FROM PROPULSIVE TO NON-PROPULSIVE CONTROL

Abstract

With the International Space Station (ISS) life extension to 2024 more emphasis is being put on preservation of the service life of the ISS and its critical components. Any propulsive event on the ISS introduces structural loads causing structure fatigue leading to the reduction in ISS service life. Also propulsive events require additional positioning of USOS appendages and in many cases parking and latching Solar Array Rotary Joints (SARJ) and Beta Gimbal Assemblies (BGA) to minimize plume impingement loads and surface contamination.

In order to reduce negative effects of propulsive control ISS Program made a decision to transition multiple dynamic events to non-propulsive control. The use of United States Orbital Segment (USOS) Control Moment Gyroscopes (CMG) during dynamic events minimizes and in most cases eliminates thruster firings leading to significant reductions in loads and contamination thus increasing flexibility in USOS appendages allowing full BGA autotrack. Implementation of CMG control eliminated multiple costly analyses and reduced use of ISS consumables saving over 300 kgs of propellant annually. Significant propellant savings were achieved by introducing Optimized Propellant Maneuver (OPM) concept, which uses a combination of propulsive and non-propulsive control methods. Designed to take advantage of the external torques acting on the ISS, this technique allows for the large maneuvers to be accomplished using as little as 1/10th of the prop required for a conventional maneuver.

The purpose of this paper is to describe specific events that were transitioned to CMG control from Russian Segment (RS) propulsive control, describe the analytical approach and the analyses results for ISS controllability, loads, contamination, and clearance for Russian Vehicle (RV) departures for nominal and contingency cases. Analysis results will also include probabilistic risk assessments of different failure case scenarios. The paper addresses analysis methodology for transitioning dynamic events such as Russian Vehicle undocking from ISS nadir and zenith ports, propellant purges and airlock depresses for RS Extra Vehicular Activities (EVA) from propulsive to CMG controlled events.

This effort required collaboration between multiple organizations within NASA/JSC and International Partners. The paper will also describe changes in ISS control logic and commanding as well as coordination process and data exchanges.